5
363.739
263
H 2mnr
1985

PLEASE RETURN

MONTANA
1985 NETWORK REVIEW

compiled by
Robert W. Raisch

STATE DOCUMENTS COLLECTION

JAN 17 1986

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620

Harold W. Robbins, Chief
Air Quality Bureau
Department of Health and Environmental Sciences
Helena, Montana 59620

August, 1985

Montana State Library
3 0864 1005 1726 0

TABLE OF CONTENTS

	Page
List of Figures	iii
List of Tables	vi
Introduction	1
Total Suspended Particulates	5
Montana East-West Contrasts	11
Statewide Trend Analysis	24
TSP Comparisons - 1983 versus 1984	27
Northwest Montana	28
Libby	29
Eureka	43
Thompson Falls	44
Kalispell	47
Columbia Falls	52
Prospective Sites	56
West Central Montana	57
Missoula	57
Hamilton	66
Ovando	68
Deer Lodge	70
Southwest Montana	72
Helena	72
East Helena	76
Montana City	94
Anaconda	95
Butte	99
Dillon	101
Bozeman	102
Prospective Sites	107
North Central Montana	108
Great Falls	108
Choteau	113
South Central Montana	115
Billings	115
Laurel	121
Prospective Sites	123
Eastern Montana	124
Malta and Plevna	124
Jordan	125
Scobey	127
Sidney	127
Glendive	129

TABLE OF CONTENTS, Continued

	Page
Ten Micron Particulate Matter - PM-10	133
Prioritization of Sites	137
Libby	137
Missoula	139
Bozeman	140
Butte	140
Helena	141
Columbia Falls	141
Kalispell	142
Billings	143
Thompson Falls	143
Western Montana Background Site	144
East Helena	144
Hamilton	145
Ronan	145
Great Falls	145
Polson	146
Eureka	146
Colstrip	147
Ramsay	147
Eastern Montana Background	148
Sarpy Creek and Decker	148
Fort Peck and Scobey	148
Economic Considerations	148
Lead	151
Anaconda	151
East Helena	152
Arsenic	158
Anaconda	158
East Helena	159
Other Trace Metals	161
Sulfates and Nitrates	163
Sulfur Dioxide	166
Scobey	166
Billings	169
Sulfation Rate	186
Carbon Monoxide	188
Billings	188
Great Falls	190
Missoula	194
Libby	196
Visibility	200
Libby	202
Prospective Sites	206
Acid Rain	207
Fluorides	209
Prioritization of Proposed Network Modifications	211
Rationale for Site Designation	214
Sampling Methods and Siting Criteria	223
References	228

LIST OF FIGURES

Figure		Page
1	Monthly TSP Means - Western Montana Composite of all Valid Sites.	15
2	Monthly TSP Means - Eastern Montana Composite of all Valid Sites.	15
3	Monthly TSP Means - Western Montna Composite of Near Town Sites	16
4	Monthly TSP Means - Western Montana Composite of Small Town Sites	17
5	Monthly TSP Means - Eastern Montana Composite of Small Town Sites	17
6	Monthly TSP Means - Western Montana Composite of Remote Sites	19
7	Monthly TSP Means - Eastern Montana Composite of Remote Sites	19
8	Monthly TSP Means - Western Montana Composite of Large City Sites	21
9	Monthly TSP Means - Eastern Montana Composite of Large City Sites	21
10	Map of Libby Monitoring Sites	30
11	Three Year Plot of TSP Data at the Brown Residence in Libby	33
12	Libby Brown's Residence Trend Analysis.	34
13	Plot of 1984 TSP Data at the Lincoln County Courthouse in Libby	36
14	Plot of Back-scattering Coefficient versus Particle Size.	41
15	Map of Eureka Monitoring Site	45
16	Map of Thompson Falls Monitoring Site	46
17	Map of Kalispell Monitoring Sites	48
18	Three Year Plot of TSP Data at the Universal Athletics Site in Kalispell.	49
19	Kalispell Universal Athletics Trend Analysis.	50
20	Plot of 1984 TSP Data at the Courthouse East Site in Kalispell	51
21	Map of Columbia Falls Monitoring Sites.	53
22	Columbia Falls Anders Residence Trend Analysis.	54
23	Map of Missoula Monitoring Sites.	59
24	Three Year Plot of TSP Data at the Rose Park Site in Missoula.	61
25	Missoula Rose Park Trend Analysis	61
26	Three Year Plot of TSP Data at the Boyd Park Site in Missoula.	63
27	Missoula Courthouse Roof Trend Analysis	64
28	Map of the Hamilton Monitoring Site	67
29	Map of the Ovando Monitoring Site	69
30	Map of the Deer Lodge Monitoring Site	71

LIST OF FIGURES, Continued

Figure		Page
31	Map of the Helena Monitoring Sites.	73
32	Helena Cogswell Building Trend Analysis	75
33	Helena Capital Courts Trend Analysis.	76
34	Map of East Helena Monitoring Sites	78
35	East Helena Hastie Residence Trend Analysis	79
36	Map of Anaconda Monitoring Sites.	96
37	Anaconda Lincoln School Trend Analysis.	97
38	Map of the Butte Monitoring Sites	100
39	Butte Greeley School Trend Analysis	101
40	Map of the Dillon Monitoring Sites.	103
41	Map of the Bozeman Monitoring Sites	104
42	Bozeman East Main City Building Trend Analysis.	105
43	Three Year Plot of TSP Data at the Whittier School in Bozeman	107
44	Map of the Great Falls Monitoring Sites	110
45	Great Falls Fire Station Trend Analysis	109
46	Great Falls Downtown Trend Analysis	111
47	Great Falls Black Eagle Trend Analysis.	113
48	Map of the Choteau Monitoring Site.	114
49	Map of the Billings Monitoring Sites.	117
50	Billings Grand Avenue Trend Analysis.	116
51	Billings City Hall Trend Analysis	119
52	Map of the Laurel Monitoring Site	122
53	Laurel Junior High School Trend Analysis.	123
54	Map of the Three Eastern Montana Remote Monitoring Sites.	126
55	Map of the Scobey Monitoring Sites.	128
56	Map of the Sidney Monitoring Site	130
57	Map of the Glendive Monitoring Site	131
58	Diurnal Plot of Sulfur Dioxide Concentrations for November, 1984, at the Border Site Near Scobey	169
59	Diurnal Plot of Sulfur Dioxide Concentrations for March, 1984, at the Coburn Road Site in Billings	176
60	Diurnal Plot of Sulfur Dioxide Concentrations for September, 1984, at the Coburn Road Site in Billings	177
61	Diurnal Plot of Sulfur Dioxide Concentrations for December, 1984, at the Coburn Road Site in Billings.	178
62	Diurnal Plot of Sulfur Dioxide Concentrations for March, 1984, at the Lockwood Park Site in Billings	180
63	Diurnal Plot of Sulfur Dioxide Concentrations for Sept., 1984, at the Lockwood Park Site in Billings	181
64	Diurnal Plot of Sulfur Dioxide Concentrations for Dec., 1984, at the Lockwood Park Site in Billings.	182
65	Diurnal Plot of Sulfur Dioxide Concentrations for March, 1984, at the North Johnson Lane Site in Billings	183

LIST OF FIGURES, Continued

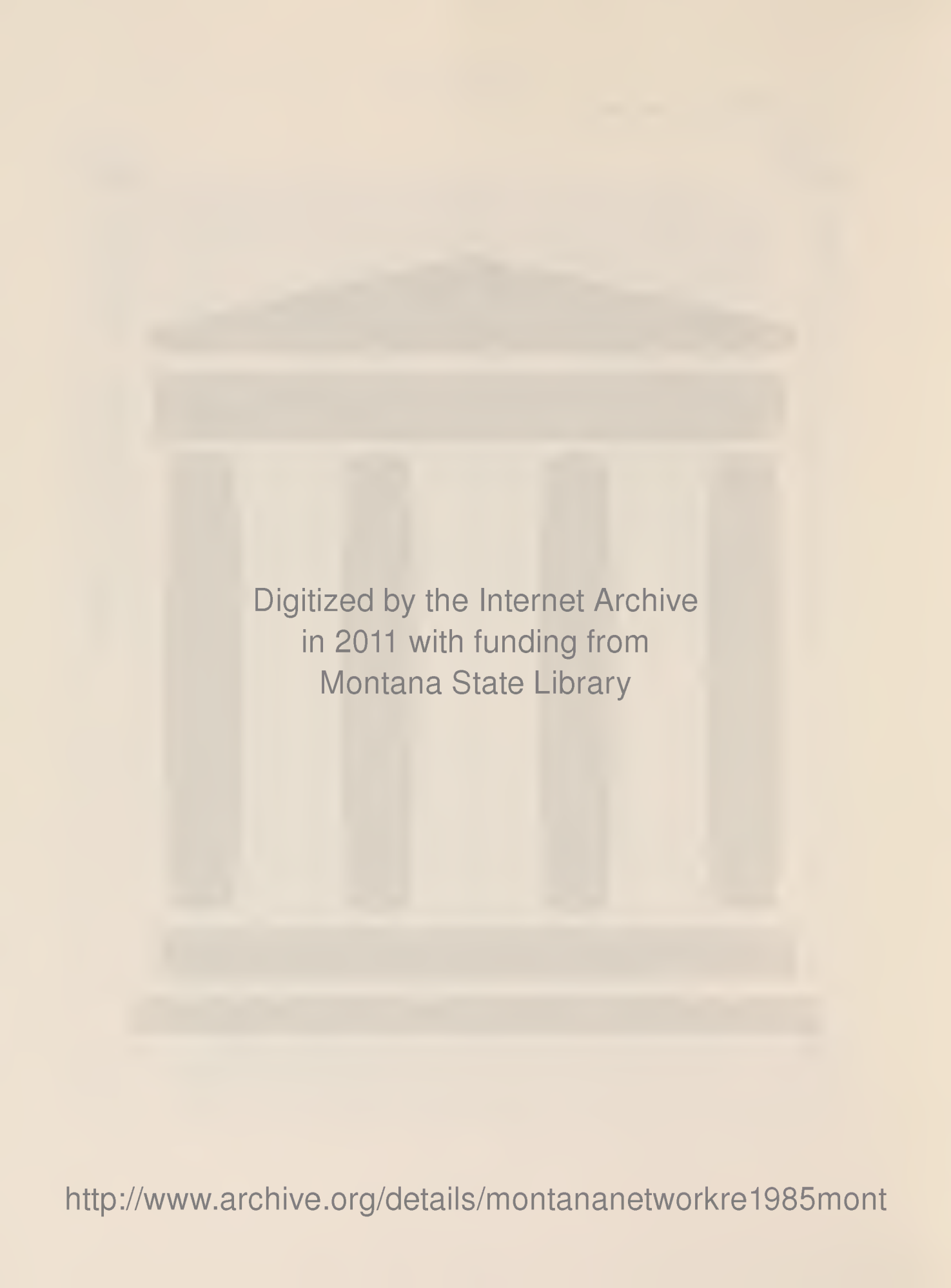
Figure		Page
66	Diurnal Plot of Sulfur Dioxide Concentrations for September, 1984, at the North Johnson Lane Site in Billings	184
67	Diurnal Plot of Sulfur Dioxide Concentrations for December, 1984, at the North Johnson Lane Site in Billings	185
68	Diurnal Plot of Carbon Monoxide Concentrations for December, 1984, at the Metra-Fairgrounds Site in Billings	189
69	Diurnal Plot of Carbon Monoxide Concentrations for February, 1984, at the Pardis Clinic in Great Falls. .	191
70	Diurnal Plot of Carbon Monoxide Concentrations for February, 1984, at the Boyd Park Site in Missoula. . .	195
71	Diurnal Plot of Carbon Monoxide Concentrations for February, 1984, at the Wrecking Yard Site in Libby . .	198
72	Diurnal Plot of Back-scattering Coefficients for February, 1984, at the Wrecking Yard Site in Libby . .	204
73	Diurnal Plot of Back-scattering Coefficients for November, 1984, at the River Site Near Libby	205

LIST OF TABLES

Table		Page
1	Monitoring Objectives and Appropriate Siting Scales	3
2	Point Source Particulate Emissions Estimates for 1984 . . .	6
3	Collocated High Volume Samplers	8
4	TSP National Air Monitoring Station Criteria.	9
5	List of Sites Used for the Regional TSP Analysis.	13
6	Summary of the Conclusions and Recommendations for the Regional TSP Analysis.	23
7	Critical Values of Spearman's Rank Correlation Coefficient.	25
8	Summary of TSP Concentrations at Montana Sampling Locations.	31
9	Libby Source Samples.	38
10	Filter Media for Libby Study.	39
11	Particle Size Distribution of TSP at the Libby Wrecking Yard Site.	40
12	Correlation Coefficients of Back-scatter and Various Size Classes of Particulates from Libby Monitoring Sites. . . .	41
13	TSP by Season and Year from the Columbia Falls Anders Residence Site	55
14	Correlation Coefficients for TSP and Trace Metals Between the Hastie Site and Other East Helena Sites.	80
15	Elemental Composition of East Helena TSP.	81
16	Correlation Coefficients for TSP and Trace Metals at the East Helena Hastie Site.	81
17	Correlation Coefficients for TSP and Trace Metals Between the Hadfield Site and Other East Helena Sites.	84
18	Correlation Coefficients for TSP and Trace Metals at the East Helena Hadfield Site.	85
19	Correlation Coefficients for TSP and Trace Metals Between the Firehall Site and Other East Helena Sites.	87
20	Correlation Coefficients for TSP and Trace Metals at the East Helena Firehall Site.	88
21	Correlation Coefficients for TSP and Trace Metals Between the Dartman Field Site and Other East Helena Sites	89
22	Correlation Coefficients for TSP and Trace Metals at the East Helena Dartman Field Site	90
23	Correlation Coefficients for TSP and Trace Metals Between the South Site and Other East Helena Sites	92
24	Correlation Coefficients for TSP and Trace Metals at the East Helena South Site	93
25	Sites Exhibiting a High or Moderate Probability of Exceeding the Proposed PM-10 Standard - Combined EPA and Montana Results.	135
26	Prioritized List of Proposed PM-10 Air Monitoring Sites . .	138
27	Proposed PM-10 Network.	150
28	East Helena Lead Monitoring Network	152

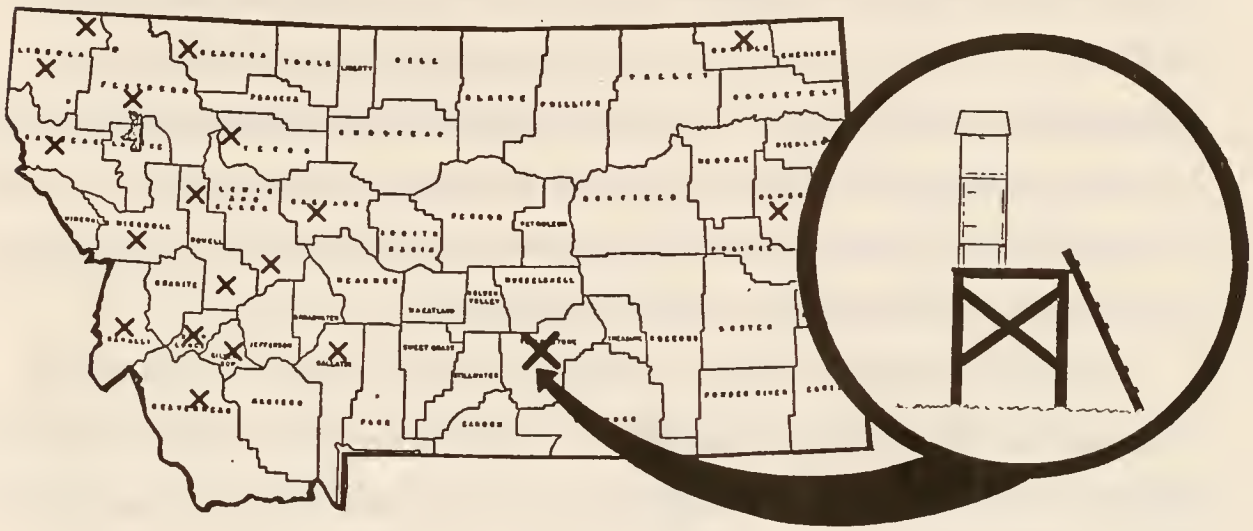
LIST OF TABLES, Continued

Table		Page
29	East Helena Lead Data for 1984.	154
30	1984 Arsenic Data for East Helena Sites	159
31	1984 Trace Metal Data	162
32	Summary of 1984 Sulfate and Nitrate Data.	165
33	Point Source Sulfur Dioxide Emission Estimates.	167
34	Summary of 1984 Sulfur Dioxide Data for Scobey.	168
35	Percent Strength Factor for Coburn Road	172
36	Percent Contribution to Ambient Sulfur Dioxide Concentrations by Source	174
37	Summary of 1984 Sulfur Dioxide Data for Billings.	175
38	1984 Exceedances of Sulfur Dioxide Standards in Billings. .	176
39	Montana Carbon Monoxide Data for 1984	189
40	Summary of 1984 Back-scattering Data from Libby	203
41	1984 Fluoride in Vegetation Data.	210
42	List of Proposed Modifications to the Montana Ambient Monitoring Network	212
43	Major Station Descriptions and Comparisons.	215
44	State of Montana, Air Quality Bureau Air Monitoring Network.	216
45	Sampling and Analysis Methods	224
46	Summaryof Probe Siting Criteria	226


Digitized by the Internet Archive
in 2011 with funding from
Montana State Library

http://www.archive.org/details/montananetworkre1985mont

INTRODUCTION



The U.S. Environmental Protection Agency (EPA) requires the Montana Department of Health and Environmental Sciences (DHES) to conduct an annual review of the state's ambient air monitoring network. This report is the seventh in the series. EPA's requirements, as set forth in 40 CFR 58.20, are (1) to determine if the system meets the monitoring objectives defined in Appendix B of 40 CFR 58.20, and (2) to identify needed modifications of the network, such as termination or relocation of unnecessary stations or establishment of new stations that may be necessary. The department is required by 40 CFR 58.25 to develop and implement an annual schedule modifying the network in order to eliminate any unnecessary stations or to correct any inadequacies indicated by the results of the annual review. The department must consult with the Regional Administrator of the EPA during the development

of the schedule to modify the monitoring program. The final schedule and modifications are subject to the approval of the Regional Administrator.

In order to conduct this review, the monitoring objective and spatial scale of representativeness of each station, existing or proposed, are first examined to determine whether they represent the air quality situation of the area. Background information, such as maps, climatological summaries, emission inventories, traffic counts, and modeling results, are gathered and reviewed. The opinions of the department staff, the personnel of three county air pollution agencies, as well as several other county health agencies, and staff members of the Helena EPA office also are solicited.

In the 1979 Network Review, the department designated each monitoring site in the state as either National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS), or Special Purpose Monitoring Stations (SPM). The NAMS/SLAMS network is designed to meet four basic monitoring objectives: (1) to determine the highest concentrations expected to occur in the area covered by the network (concentration); (2) to determine representative concentrations in areas of high population density (population); (3) to determine the impact on ambient pollution levels of significant sources or source categories (source); and (4) to determine general background concentration levels (background). Each station in the NAMS/SLAMS network also is sited so that the air sampled is representative of certain spatial scales, which are defined as follows:

Microscale: defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.

Middle Scale: defines the concentrations typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometers.

Neighborhood Scale: defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.

Urban Scale: defines the overall city-wide conditions with dimensions on the order of 4 to 50 kilometers. This scale usually requires more than one site for definition.

Regional Scale: usually defines a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.

National and Global Scales: these measurement scales represent concentrations characterizing the nation and the globe as a whole.

In order to site a monitoring station properly, both the monitoring objective and the spatial scale of representativeness must be determined. Appropriate siting scales for the various monitoring objectives are listed in Table 1.

TABLE 1

MONITORING OBJECTIVES AND APPROPRIATE SITING SCALES

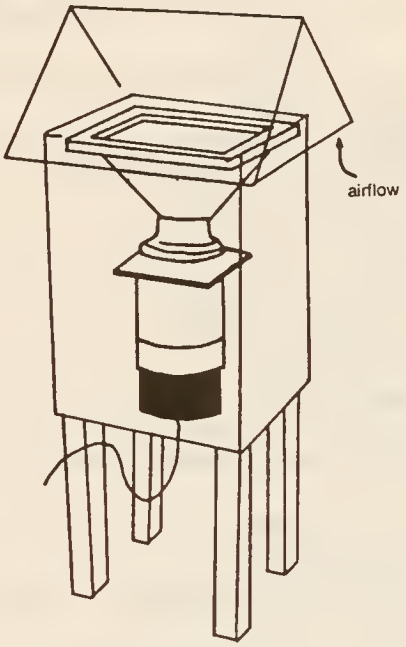
Monitoring Objective	Siting Scales
Highest concentration	Micro, middle, neighborhood (sometimes urban)
Population	Neighborhood, urban
Source impact	Micro, middle, neighborhood
Background	Neighborhood, regional

The goal in siting stations is to match correctly the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for each station's monitoring objective. During the process of the first network review in 1979, existing stations were evaluated for their

monitoring objective and siting scale and, when necessary, were modified. New stations established since then have been sited in accordance with the monitoring objective and siting scale determined in advance.

The department developed this comprehensive network review to serve as a basis for a less intensive supplement to be developed in 1986. The department intends to perform a comprehensive review every two years.

Total Suspended Particulates



TSP is the most common pollutant in Montana and affects the entire state. The major sources of particulates are industrial activity, coal mines, traffic on paved and unpaved roads, agricultural activity and residential wood burning. Table 2 lists the particulate emissions from the major industrial sources throughout Montana. The highest particulate concentrations in Montana are found in urban areas such as Billings, Bozeman, Butte, Helena, Kalispell, and Missoula, or smaller towns in western Montana such as Libby and Thompson Falls. Particularly in the western valleys, winter inversions allow particulate levels to increase and to remain high for days or weeks at a time. Some rural areas also show high particulate levels, due primarily to agricultural activities and unpaved roads.

All of Montana's TSP monitors are sited according to the neighborhood, or regional scale (see Table 44). Selection of the appropriate siting

TABLE 2

POINT SOURCE PARTICULATE EMISSION ESTIMATES FOR 1984

Source	Part. Tons/Yr.	County	City
Exxon Co. USA	1423	Yellowstone	Billings
Continental Oil Co.	320	Yellowstone	Billings
Montana Power Co. (Corette)	578	Yellowstone	Billings
East Decker Coal	* 910	Bighorn	Decker
Westmoreland Resources	* 601	Bighorn	Hardin
Cenex	643	Yellowstone	Laurel
West Decker Coal	* 744	Bighorn	Decker
Spring Creek Coal	* 291	Bighorn	Decker
Western Sugar	2369	Yellowstone	Billings
Bighorn Calcium	* 284	Carbon	Warren
Cereal Food Processors	206	Yellowstone	Billings
Spring Creek Forest Products	* 53	Wheatland	Judith Gap
Kaiser Cement	*1495	Jefferson	Montana City
ASARCO smelter	734	Lewis&Clark	East Helena
Ideal Basic Industries	* 154	Gallatin	Trident
Stauffer Chemical Co.	941	Silver Bow	Ramsay
Pfizer Talc	408	Beaverhead	Dillon
Cyprus Ind. Minerals-Yell. Mine	* 856	Madison	Ennis
Louisiana Pacific Corp.	152	Powell	Deer Lodge
Cominco	* 102	Powell	Garrison
Western Energy	*2521	Rosebud	Colstrip
Montana Power Co. 1 and 2	989	Rosebud	Colstrip
Peabody Coal	* 417	Rosebud	Colstrip
Montana Dakota Utilities	426	Richland	Sidney
Holly Sugar	81	Richland	Sidney
Montana Power Colstrip #3	1160	Rosebud	Colstrip
Knife River Coal	* 97	Richland	Savage
St. Regis Paper Co.	861	Lincoln	Libby
Missoula White Pine & Sash	* 177	Missoula	Missoula
Champion Int./Frenchtown	1094	Missoula	Frenchtown
Champion/Bonner	102	Missoula	Bonner
Louisiana Pacific Particleboard	705	Missoula	Missoula
Plum Creek Lumber	* 238	Lake	Pablo
Flathead Lumber	225	Lake	Polson
Plum Creek Lumber	254	Flathead	Columbia Falls
Plum Creek Lumber	90	Flathead	Kalispell
Flodin Lumber	* 53	Sanders	Thompson Falls
W. I. Forest Prod. Inc.	* 75	Sanders	Thompson Falls
American Timber	* 159	Flathead	Olney
Stoltze Land & Lumber	* 232	Flathead	Columbia Falls
W. R. Grace Co.	271	Lincoln	Libby
Pyramid Mountain Lumber	* 64	Missoula	Seeley Lake
Champion Int./Intermountain	76	Missoula	Missoula
Ksanka Lumber	* 86	Lincoln	Fortine
ASARCO-Troy	* 190	Lincoln	Troy

*Fugitive emissions associated with mining and vehicle traffic are included.

scale is dependent on the station's monitoring objective. The monitoring objective for most stations is "population." All of the "population" stations are sited according to the "neighborhood" scale, which corresponds to areas with dimensions from 0.5 to 4.0 kilometers.

For those stations designed to determine the impact of particulate sources on ambient particulate concentrations, the monitoring objective is "source." Most of the particulate monitoring around air pollution sources is conducted by the companies responsible for the emissions. The department receives data from company sites and conducts periodic audits of the sites and data. All "source" stations are sited according to the "neighborhood" scale with the exception of the Scobey Border Station, which is scaled regionally.

Several stations in urban areas are designed to monitor areas of highest concentration, and are sited according to the "neighborhood" scale.

"Background" stations are chosen to determine concentrations of particulates in areas remote from man-made sources. The department recommends two background stations for Montana, one in the eastern part of the state to characterize background concentrations in the plains, and another in a western valley for the mountainous portion of the state. The site at the Terry Smith Ranch near Ovando, in Powell County, serves as the western Montana background station while Jordan, in Garfield County, comprised the eastern Montana station until May, 1984, when the operator no longer had time to operate it. Both background sites were cited according to the "regional" scale of representativeness. The department removed the site at Jordan because there were no other prospective operators within a reasonable driving distance of the site. Although the department staff considers it important to have an eastern Montana background site, we are not planning to establish a new one because of inadequate funding.

Appendix A of 40 CFR 58 requires that at least two stations in the network be selected for duplicate sampling and that two samplers be collocated at these sites. Sites with the highest expected geometric mean concentrations must be chosen. The department started collocated TSP sampling at the Lincoln County Courthouse in Libby in August, 1984. This site replaced the Butte Greeley School collocated site because of its higher geometric mean. The Greeley School collocated sampler was removed on December 30, 1984. The department also operated collocated samplers at the Taft School site in Billings until June, 1985. In June, the Yellowstone County Air Pollution Control Agency took over the site and shut down the collocated sampler. The county operates collocated samplers at the City Hall site and the additional collocated sampler was not necessary. Since the department is already operating collocated sites in East Helena and Libby, a new site will not be established. Table 3 lists the stations where the department and the three county agencies operate collocated samplers.

TABLE 3
COLLOCATED HIGH VOLUME SAMPLERS

City	Site
Billings (DHES) (shut down - June 1985)	Taft School (NAMS)
Billings (County)	City Hall (SLAMS)
Great Falls (County)	Downtown (NAMS)
Missoula (County)	Health Dept. Roof (SLAMS)
Missoula (County/Industry)	HW#1 (SPM)
East Helena (DHES/Industry)	Hadfield (SLAMS)
Libby (DHES)	Lincoln Co. Courthouse (SLAMS)

Montana's network of NAMS stations for TSP consists of two stations selected from the SLAMS network. NAMS are required in urban areas larger than 50,000 population. In Montana only Great Falls and Billings have Standard Metropolitan Statistical Areas with populations in excess of 50,000. The TSP

NAMS criteria are given in Table 4. Based on these criteria, both Billings and Great Falls fall into the "medium" concentration range and thus require one to two NAMS stations each. The department operated a NAMS station at the Taft School in Billings until June, 1985, when Yellowstone County took over the operation. The Yellowstone County Air Pollution Control Agency wants to move the NAMS site to the City Hall and shut down the Taft School site. The Cascade County Health Department also runs a NAMS site at the public library in downtown Great Falls. In the 1984 Network Review, the department recommended to EPA that two NAMS sites be established in Missoula. EPA rejected the proposal because the agency is actually in the process of reducing the number of NAMS sites on a nationwide basis.

TABLE 4

TSP NATIONAL AIR MONITORING STATION CRITERIA*

Population Category		Concentration		
		High	Medium	Low
High Population	over 500,000	6-8	4-6	0-2
Medium Population	100,000-500,000	4-6	2-4	0-2
Low Population	50,000-100,000	2-4	1-2	0

*Approximate number of stations per area

High concentration - exceeding level of the primary NAAQS by 20 percent or more.
Medium concentration - exceeding secondary NAAQS.
Low concentration - less than secondary NAAQS.

The department performed several statistical analyses on TSP data during the preparation of this report. In contrast to the statistical analyses performed in earlier network reviews, the department concentrated on regional data patterns and trend analyses. However, some site specific analyses were performed. Most of the analyses, including the regression analyses, were done

on the state's IBM 3033N computer using the Air Quality Data Handling System (AQDHS II) as a direct source of input data for the SPSS computer software package (Statistical Package for the Social Sciences). Annual and three year plots of monthly TSP means were made using the department's WTC 850 computer and Soltec 281 plotter. The trend analyses were performed by hand calculator.

Throughout the 1985 network review, the department used the following arbitrary rating scheme to interpret the results of each linear regression:

a. correlation coefficients 0.900 to 1.000 = excellent

b. correlation coefficients 0.800 to 0.900 = very good

c. correlation coefficients 0.700 to 0.800 = good

d. correlation coefficients 0.600 to 0.700 = fair

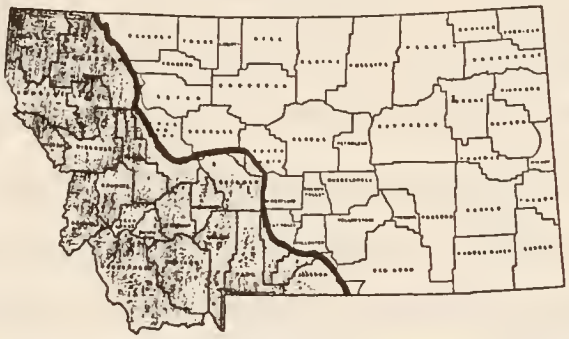
e. correlation coefficients 0.500 to 0.600 = poor

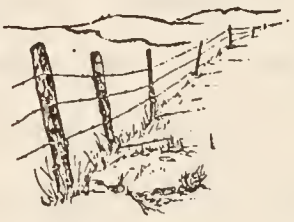
f. correlation coefficients 0.400 to 0.500 = very poor

Although there are other statistical ways to interpret the significance of a correlation coefficient, the department chose to develop a structured scheme and apply it consistently throughout the review.

It should be noted that the recommendations for maintaining or terminating a station are based on a number of criteria including projected growth in the area of the sampling site, the pollutant concentrations at the site (especially if they equal or exceed the standards) and funding. Table 42 is a prioritized list of the proposed network modifications. The department will use this list in conjunction with budget projections to determine what modifications will be implemented.

MONTANA EAST--WEST CONTRASTS





For the purpose of this discussion, the department divided Montana into two broad zones based on differences in climate and geography. The above figure delineates the two zones. The department decided to compare TSP data between zones because we suspected major differences and hoped the results would help prioritize our monitoring efforts.

The western zone is characterized by high forested mountains rising to 10,000 feet and semiarid valleys with elevations ranging from 2000 to 6000 feet above sea level. Temperatures, precipitation, and wind patterns vary drastically throughout this region. Annual precipitation is extremely variable, but generally increases with elevation. Over 80 inches of precipitation fall annually on some mountain ranges while nearby valleys may receive as little as 10 inches. Temperatures usually decrease with elevation, although nocturnal temperature inversions occur at all times of the year and extended inversions, lasting for days, are common during the fall and winter. The north-south orientation of many of the mountain ranges restricts the normal west to east air flow resulting in very light valley winds.

The eastern zone consists of a high semiarid plain occasionally broken by shallow river and stream valleys as well as a few isolated mountain ranges. The valleys are generally less than 300 feet below the surrounding prairie. Temperatures, precipitation, and wind patterns are more uniform throughout eastern Montana. The wide open spaces common to this area allow good air movement and temperature inversions are less frequent and not as persistent.

The geographical and climatic differences between these two zones have a dramatic impact on air quality. In addition, the emission sources in the two areas are quite different. In order to highlight the air quality differences between the two areas, the department decided to compare monthly means and seasonal patterns of TSP between regions. Since the type and number of monitoring sites varied between regions, the department decided to establish several subcategories of sites based on population density: (1) remote, (2) near town, (3) small town (pop. <8000), and (4) large city (pop. >8000).

The department did not include all the sites in the analysis, since some sites had incomplete 1984 data sets. We selected only those monitoring sites which recorded over 35 valid readings in 1984. In addition, the readings had to be evenly distributed throughout the year. Following this criteria, the department selected 25 western Montana sites and 10 eastern Montana sites. The department assigned each of the 35 sites to the proper subcategory (see Table 5).

The department weighted the monthly means for each subcategory by considering the total number of samples collected during the month at each site. In other words, the monthly arithmetic mean at each site was multiplied by the number of samples comprising the mean. The resultant values from each site were added and the total was divided by the total number of samples from all the sites in the subcategory. This procedure minimized the effect of sites

TABLE 5

LIST OF SITES USED FOR THE REGIONAL TSP ANALYSIS

Region	Subcategory	Nearest Community	Site	No. of Observations
Western Montana	Remote	Ovando	Smith Ranch	47
		West Glacier	Fire Weather Sta.	48
	Near town	Montana City	School	40
		East Helena	South	60
		East Helena	Dartman Field	59
	Small town	East Helena	Hastie Residence	107
		East Helena	Firehall	115
		East Helena	Hadfield TV	116
		Columbia Falls	Anders Residence	60
		Libby	Brown Residence	53
		Libby	Lincoln Co.Crthse.	54
		Hamilton	Ravalli Co.Crthse.	51
		Thompson Falls	Sanders Co.Crthse.	47
	Large city	Anaconda	Lincoln School	54
		Bozeman	Whittier School	45
		Helena	Cogswell Building	57
		Helena	Capital Courts	54
		Helena	Cooney Home	50
		Kalispell	Universal Athl.	39
		Kalispell	Courthouse East	59
		Missoula	Courthouse Roof	353
		Missoula	Rose Park	346
		Missoula	Boyd Park	341
		Missoula	Meadow Hill	92
		Missoula	Spurgin & Tower	113
Eastern Montana	Remote	Malta	Bowdoin NWR	51
		St. Mary	Park Ranger Sta.	45
	Small town	Laurel	Junior High Sch.	55
	Large city	Billings	City Hall	59
		Billings	Grand Ave.	55
		Billings	Taft School	54
		Billings	Sandstone Sch.	54
		Great Falls	Fire Station	59
		Great Falls	Downtown	51
		Black Eagle	Post Office	59

with only one or two samples in a month and emphasized the effect of sites with numerous samples.

The department notes that the Missoula sites and some of the East Helena sites operated on a more frequent sampling schedule than the rest of the network. As a result, more data was collected in these areas and may have biased the results. Table 5 lists the sites by subcategory and can be of assistance in determining what subcategories were affected.

Figure 1 shows the results of compositing all 25 western Montana sites and Figure 2 displays similar data for the 10 eastern Montana sites. The annual arithmetic mean for the eastern region is 53.2 ug/m^3, while the mean for the western region is substantially higher at 66.5 ug/m^3. The department believes this information reinforces the idea that most of Montana's particulate problems are in western Montana. The department considers the seasonal differences in TSP levels to be even more significant. The western Montana graph shows that the highest particulate concentrations occurred in the late fall and winter. A moderate increase in particulates also occurred in July and August, sandwiched between low concentrations in spring and early fall. On the other hand, the eastern Montana sites exhibited relatively constant concentrations year-round. However, similar to western Montana, a moderate peak occurred during July and August. The department attributes the high summertime concentrations observed in both regions to fugitive dust sources such as agricultural activity, re-entrained road dust, and windblown dust. July and August are normally hot and dry throughout Montana. The August levels may also have been impacted by several very large forest and range fires burning throughout the state during the last two weeks of the month. The very high levels recorded in western Montana during the winter are probably caused by residential wood burning and aggravated by persistent

FIGURE 1

WESTERN MONTANA
COMPOSITE OF ALL
VALID SITES

Total Suspended Particulate
micrograms per cubic meter

1984 MONTHLY WEIGHTED MEANS

25 Sites

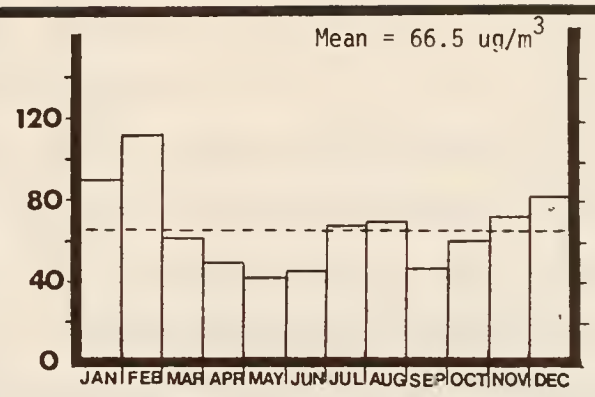


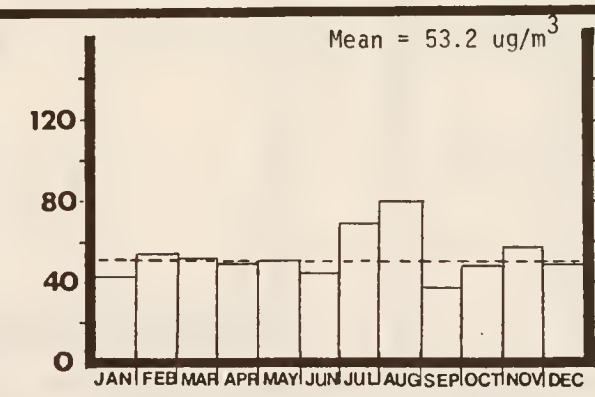
FIGURE 2

EASTERN MONTANA
COMPOSITE OF ALL
VALID SITES

Total Suspended Particulate
micrograms per cubic meter

1984 MONTHLY WEIGHTED MEANS

11 Sites



temperature inversions which restrict air movement. Due to better ventilation conditions and very little residential wood burning, eastern Montana does not experience this phenomenon.

The department classified three western Montana sites as "near town" sites (see Figure 3). These sampling locations included two rural sites within one mile of East Helena and the Montana City School site. There were no eastern Montana sites in this category. The "near town" sites exhibited a similar increase in particulate concentrations during July and August. In October, November, and especially December, concentrations were also elevated; however, January and February were low. The low values for January and February were exactly opposite to the pattern established for all western Montana sites. The department is unable to explain this difference.

Figures 4 and 5 provide graphical displays of the monthly TSP means for the eight western Montana small town sites and the one eastern Montana small

FIGURE 3

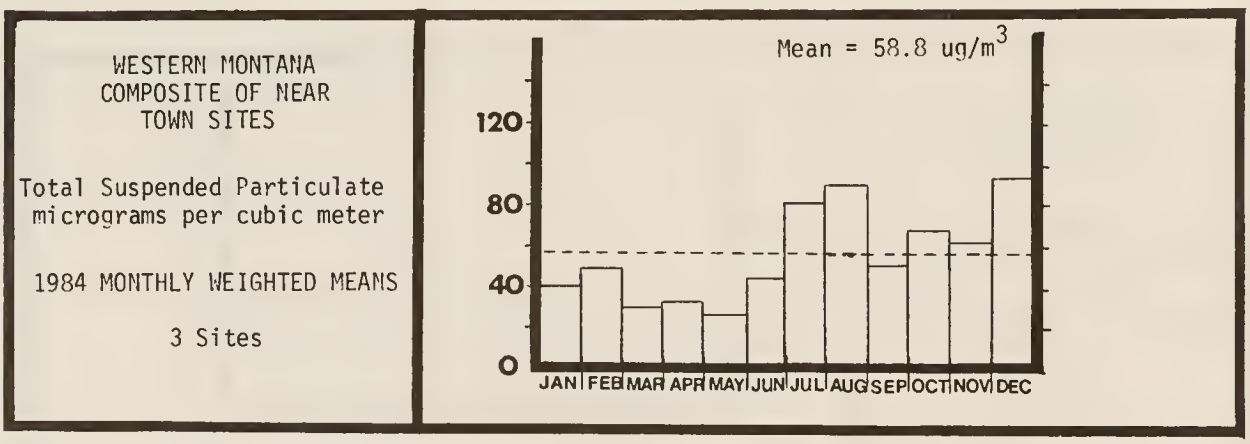


FIGURE 4

WESTERN MONTANA
COMPOSITE OF SMALL
TOWN SITES

Total Suspended Particulate
micrograms per cubic meter

1984 MONTHLY WEIGHTED MEANS

8 Sites

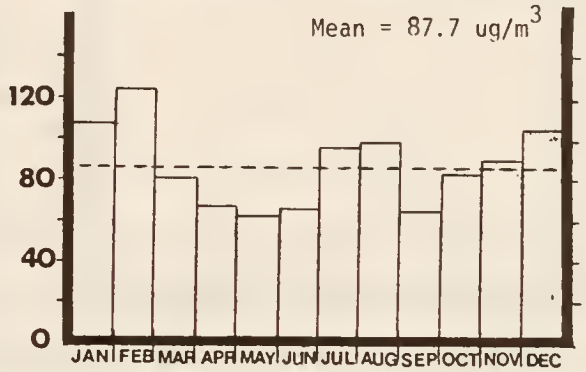


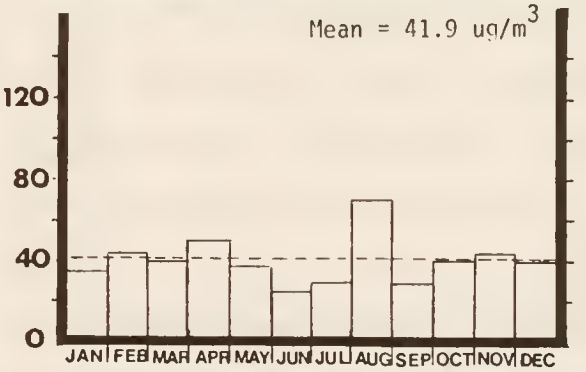
FIGURE 5

EASTERN MONTANA
COMPOSITE OF SMALL
TOWN SITES

Total Suspended Particulate
micrograms per cubic meter

1984 MONTHLY WEIGHTED MEANS

1 Site



town site. Since there is only one eastern Montana site in this subcategory, the department limited its discussion to the western Montana sites. The most notable piece of information contained in the western Montana graph is the very high (87.7 ug/m^3) annual arithmetic mean. In fact, this is the highest mean observed for any subcategory of sites including the larger cities. The seasonal pattern is almost identical to that of the western Montana composite sites except it is generally 20 percent higher. The major emission sources impacting western Montana's small towns are residential wood burning, re-entrained road dust and the wood products industries. These same sources are also present in the larger cities of western Montana. The department believes that TSP concentrations are higher in the small towns because they do not have winter emergency episode programs, natural gas is unavailable and their street cleaning equipment is inadequate. Missoula and Helena operate winter emergency episode programs and have experienced some success at reducing winter particulate levels. The small western Montana towns do not have such programs. In most cases, natural gas is not available in smaller towns and, therefore, the residents rely almost exclusively on wood as a source of heat. In addition, the department suspects that spring and summer concentrations are higher because small towns can not afford good street cleaning equipment.

The department identified two remote sites in each of the regions (see Figures 6 and 7). Both figures indicate very low TSP concentrations throughout the year, with the exception of summer, when particulate levels jump. The increase is most pronounced in western Montana where monthly concentrations go up from less than 10 ug/m^3 in April to over 80 ug/m^3 in August. In eastern Montana, the TSP concentrations also peak in August, but at only 32 ug/m^3. The high TSP concentrations observed during August were probably caused by smoke from forest and range fires and fugitive dust due to dry

FIGURE 6

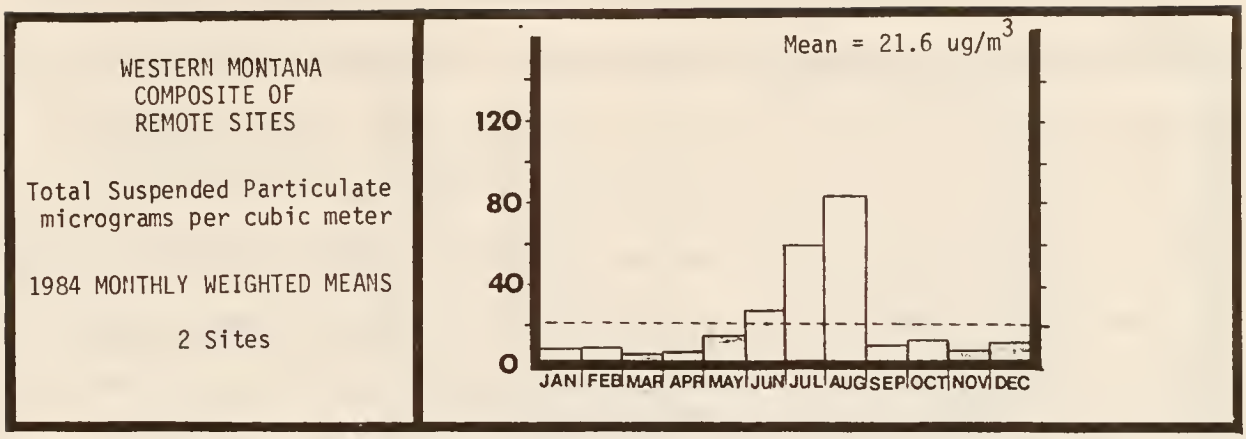
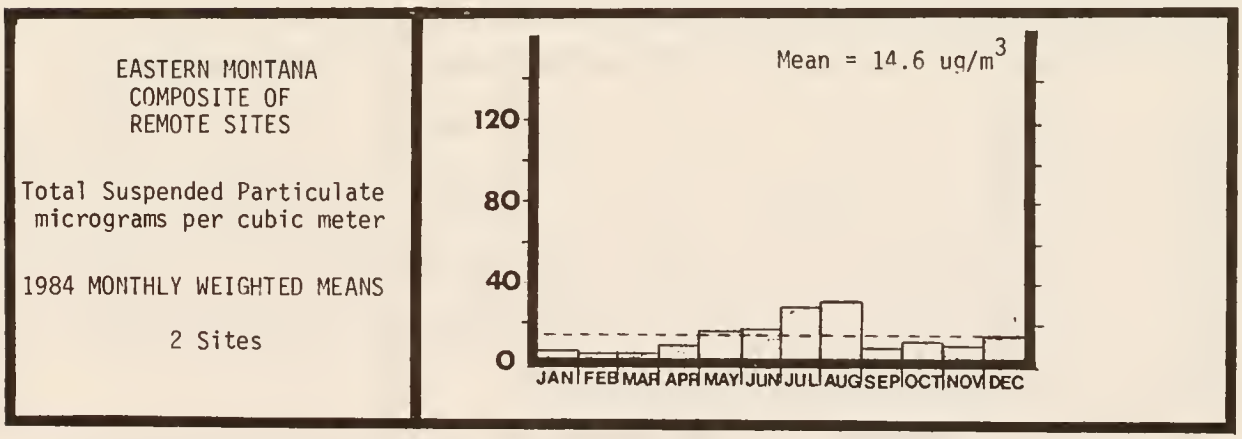


FIGURE 7



summertime weather. However, the Ovando site was also influenced by fugitive dust from an adjacent sheep sorting pen on at least two sample days.

Figures 8 and 9 describe the monthly particulate concentrations for the large city sites in eastern and western Montana. The seasonal patterns for the large city sites are very similar to the regional patterns for all sites. This is not surprising since the large cities of Missoula, Great Falls and Billings account for most of the samples collected in their respective region.

Interestingly, the large city sites in both regions recorded identical arithmetic means during 1984. However, the seasonal patterns were different. The western Montana large city sites registered their highest TSP concentrations during the winter months. This pattern is similar to the western Montana small town sites and is probably due to residential wood smoke. Data from the eastern Montana large city sites showed very little seasonal variation. The only exception was the summer peak. Another interesting observation is that the large city sites in eastern Montana have an annual mean which is 15 percent higher than the mean for all eastern Montana sites. In western Montana, the reverse is true and the mean for the large city sites is 6 percent lower than the mean for all the sites.

Based on these analyses, the department intends to limit the amount of particulate sampling done in eastern Montana. The department will concentrate its eastern Montana activities in Great Falls, Billings, and Sidney. TSP concentrations are generally low in eastern Montana and caused by fugitive dust. When the EPA finalizes the proposed PM-10 standard, most eastern Montana particulate sites will easily comply.

On the other hand, the department plans to expand TSP monitoring in selected western Montana communities. TSP levels are higher in western

FIGURE 8

WESTERN MONTANA
COMPOSITE OF LARGE
CITY SITES

Total Suspended Particulate
micrograms per cubic meter

1984 MONTHLY WEIGHTED MEANS

12 Sites

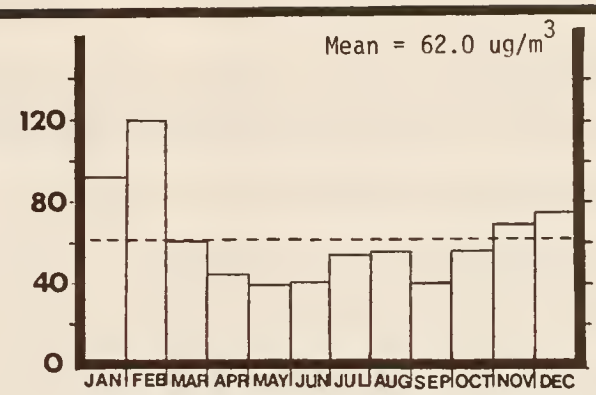


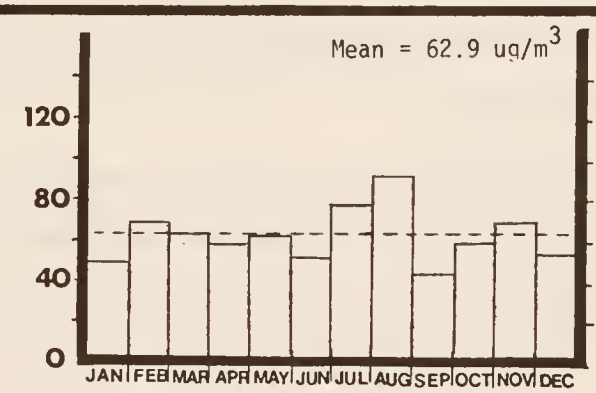
FIGURE 9

EASTERN MONTANA
COMPOSITE OF LARGE
CITY SITES

Total Suspended Particulate
micrograms per cubic meter

1984 MONTHLY WEIGHTED MEANS

8 Sites



Montana and many of the major emission sources are combustion processes, such as residential wood burning, forestry slash burning, tepee burners, hog fuel boilers, and veneer dryers. Combustion sources are major emitters of fine particulates, which are collected by the new PM-10 monitors.

The department will select specific communities in western Montana for intensive monitoring. The monitoring objective will be to identify emission sources and their contribution to TSP. The first two communities to be studied will be Kalispell and then Bozeman. The department chose these communities based on several criteria including: (1) existing air quality, (2) population and expected population growth, (3) residential wood use, (4) proximity to a wood supply, (5) availability of qualified local assistance, and (6) the number of wood combustion sources present in the area. The selection process is described in more detail in "The Draft Protocol for Source Apportionment Studies in Kalispell and Bozeman." The department intends to start the Kalispell study in September, 1985.

In addition to the in-depth studies in Kalispell and Bozeman, the department would like to extend TSP sampling to several smaller western Montana communities such as Superior and West Yellowstone. The department anticipates that monitoring in these areas will have to wait until at least 1987 because of insufficient funding.

The department summarized the conclusions and recommendations derived from the eastern versus western Montana comparisons and listed them in Table 6.

TABLE 6

SUMMARY OF THE CONCLUSIONS AND RECOMMENDATIONS
FOR THE REGIONAL TSP ANALYSIS

Conclusions

1. Particulate concentrations increased during July and August throughout the entire state, probably due to fugitive dust emissions.

2. Large forest and range fires may have contributed to the high August levels.

3. Except for July and August, eastern Montana concentrations were relatively constant.

4. Large cities in eastern Montana exhibited mean particulate levels similar to large cities in western Montana.

5. Western Montana small towns had higher TSP concentrations than all other subcategories of sites throughout Montana.

6. Western Montana's small towns registered high concentrations, probably because they have inadequate street cleaning equipment, natural gas is unavailable and residents rely on wood heat, and they do not have air pollution control programs.

7. Western Montana sites recorded their highest particulate concentrations during the late fall and winter, probably because of residential wood burning.

8. Remote sites throughout Montana recorded very low readings, although increases were noted during July and August.

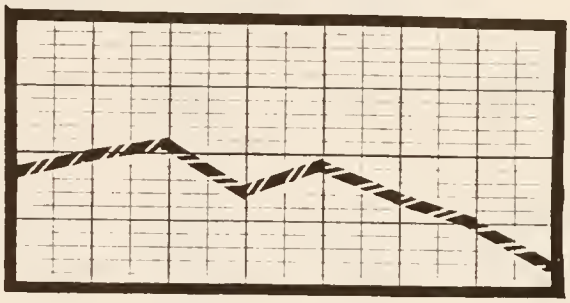
9. Particulate levels in western Montana were aggravated by poor atmospheric mixing, especially during fall and winter.

Recommendations

1. Limit particulate monitoring in eastern Montana to Great Falls, Billings and Sidney.

2. Designate specific areas of western Montana for intensive particulate monitoring designed to identify emission sources and their contributions to ambient levels.

STATEWIDE TREND ANALYSIS



The department perfonned a trend analysis on the total suspended particulate data from eighteen sampling locations. The Spearman coefficient of rank correlation was used to measure the correspondence of the rank of the annual TSP means and the time ordered rank of the sampling year. The department only considered monitoring sites which were active in 1984 and had at least five years of data. Sites were also disqualified if any of the applicable years had less than 30 valid samples. The Spearman coefficient was calculated for the last five years as well as the total years for which data was available at the site. The department compared the calculated coefficients against the critical values listed in Table 7. These critical values coincide with the 90 percent probability level.

The department discusses the trend analysis results for each individual site in the sections for the associated community. However, some statewide comments about the trend analysis seem appropriate here.

Over the last five years, only three sites indicated downward trends which were significant at the 90 percent probability level. Five sites exhibited a significant downward trend when data which was collected over the entire site history was considered. Although these results generally do not individually indicate statistically significant trends, when viewed as a

TABLE 7

CRITICAL VALUES OF SPEARMAN'S RANK CORRELATION COEFFICIENT[1]

n	Critical Value[2]
5	0.900
6	0.829
7	0.714
8	0.643
9	0.600
10	0.564
11	0.536
12	0.497
13	0.475
14	0.457
15	0.441

---

[1] The Spearman's rank correlation coefficient is calculated as follows:

$$p = 1 - \frac{6S}{n^3 - n}$$

Where: p = Spearman Rank Correlation Coefficient

$s = \sum_{i}^{n} d^2$

n = number of years in the trend

$d = R_i - i$

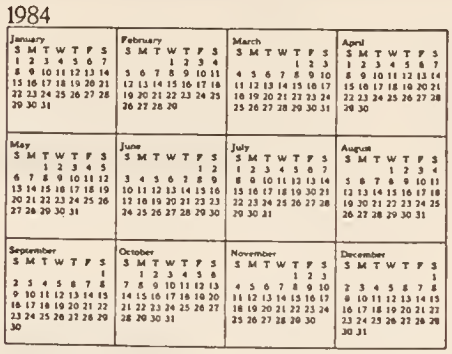
R = rank of the concentration with 1 being lowest

i = order of the year with 1 being the first year

[2] The critical values are at the 90 percent probability level.

whole, they do. Data from only one of the eighteen sites indicated increasing TSP with time and that was reversed in the most current five years. The department is impressed by the fact that over 96 percent of the coefficients indicated at least a slight probability of a downward trend.

The department wishes to point out, however, that year-to-year variations in meteorological conditions can have a significant impact on total suspended particulates. Some of the important meteorological parameters include: the amount of precipitation, the duration of snow cover, and the frequency, severity and duration of temperature inversions. The department did not normalize any of the total suspended particulate data for meteorological conditions, although we realize it would improve the analysis. However, some of the sites had up to 14 years of data, which would tend to reduce the influence of meteorological variations.



TSP COMPARISONS

1983 VERSUS 1984

The department compared the 1983 TSP data with the 1984 data and made some generalizations which are discussed in this section. The department only considered data from sites which recorded at least eight months of valid data in both 1983 and 1984. This limited the review to 33 sites, of which 24 were in western Montana and nine were in eastern Montana.

In 1984, 22 sites recorded annual geometric means which were higher than 1983, 9 sites showed decreases, and 2 remained the same. The average statewide change was an increase of 3.2 ug/m^3. This increase reversed a pattern of decreasing TSP concentrations during the two prior years. The department believes that after two years of excellent ventilation, dispersion conditions returned to normal in 1984 and may have contributed to higher concentrations. In addition, 1984 was a very dry year which may have increased fugitive dust emissions.

In the mountainous portion of Montana, 12 sites registered an increase in TSP levels during 1984, while 8 went down and 2 remained the same. Overall, a 2.4 ug/m^3 increase was observed.

All but one of the eastern Montana sites showed an increase in TSP during 1984. The average increase was 5.6 ug/m^3 and was most likely due to the persistent drought conditions throughout the region.

NORTHWEST

MONTANA

Northwest Montana includes Flathead, Lake, Lincoln, Mineral and Sanders Counties. This part of Montana is very mountainous and heavily forested. The valleys of northwestern Montana probably have the poorest atmospheric dispersion conditions of anywhere in the state.

The Flathead and Mission Valleys are prominent physical features in northwest Montana. Both valleys are part of the Rocky Mountain Trench which runs north and south from northern British Columbia to Darby, Montana. The two valleys are separated by the 28-mile-long Flathead Lake. The valley floors lie approximately 3000 feet above sea level with the 9000 foot high Swan and Mission Ranges immediately to the east. The mountains to the west are significantly lower (5000-6000 feet) and more gently sloped. Both valleys are 10 to 20 miles wide. In light of the high TSP concentrations recorded in this area, the department will continue to expand particulate monitoring in northwest Montana.

Libby

1. Libby is a small town of 3300 people lying along the Kootenai River in extreme northwestern Montana. The Kootenai valley runs approximately east and west in the vicinity of Libby with lesser valleys extending north and south along Pipe Creek and Libby Creek.
2. Libby probably has the worst ventilation of any community in Montana. During the winter, winds are almost always calm or very light. In the fall, the department releases and tracks pilot balloons with temperature mini-sondes as part of the Montana Smoke Management Plan. The objective is to determine surface winds, upper level winds and temperatures for dispersion forecasting. The data from the Libby release site was summarized in the 1983 Network Review and essentially reinforces the fact that Libby winds are very light and temperature inversions are common.
3. The department operated two high volume samplers in the town of Libby during 1984. Figure 10 is a map of Libby indicating the site locations. Table 8 summarizes the associated TSP data.
4. The Brown Residence site is located in a residential area one-half block off U.S. Highway 2 and across the highway from the Champion International sawmill and plywood plant (formerly the St. Regis Paper Co.). The Brown Residence site is scheduled to be shut down during August, 1985 in accordance with the 1984 Network Review. An analysis conducted for the 1984 Network Review indicated that the Lincoln County Courthouse site registers similar TSP concentrations to the Brown Residence site and better meets siting criteria. Therefore, the department decided to shut down the Brown Residence sampler.

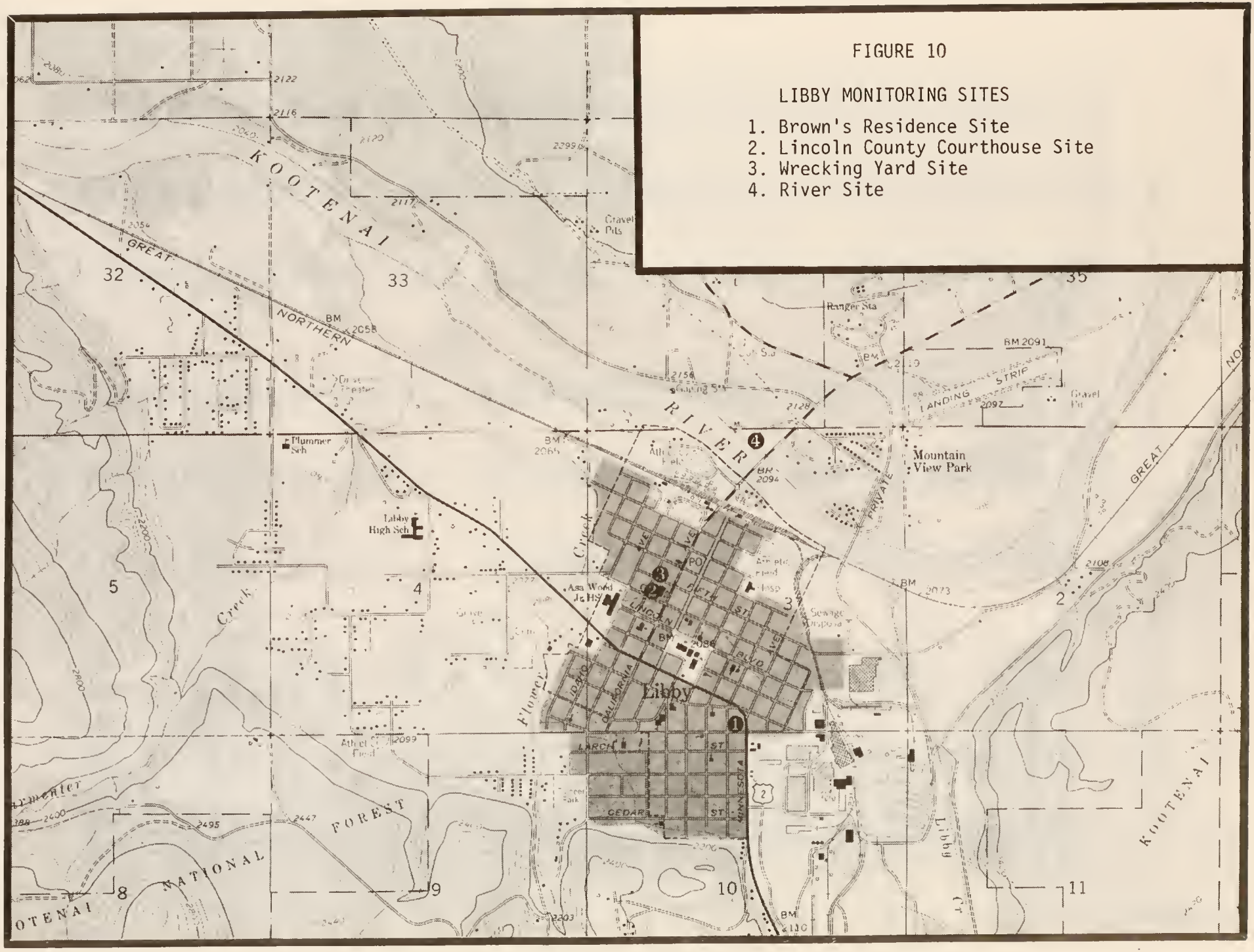


FIGURE 10

LIBBY MONITORING SITES

1. Brown's Residence Site
2. Lincoln County Courthouse Site
3. Wrecking Yard Site
4. River Site

TABLE 8

SUMMARY OF TSP CONCENTRATIONS AT MONTANA SAMPLING LOCATIONS

	1983			1984		
	Geo. Mean ug/m^3	1-High ug/m^3	2-High ug/m^3	Geo. Mean ug/m^3	1-High ug/m^3	2-High ug/m^3
Libby-Brown Residence	96	278	250	107	378	324
Libby-Lincoln Co.Crths.	90	278	207	103	463	364
Eureka-Lincoln Elec.Coop.	---	---	---	54*	349	276
Whitefish-Park	62*	197	159	---	---	---
Kalispell-Univ.Athletics	72	370	210	70	209	152
Kalispell-Courthouse East	45	129	102	47	160	133
Polebridge	12*	68	63	---	---	---
Col. Falls-Anders Res.	69	274	199	91	437	407
Columbia Falls-NAAC	14*	21	9	---	---	---
Glacier Nat.Pk.-West #5	9	40	35	9	129	58
Glacier Nat.Pk.-East #8	8	33	31	7	71	58
Bigfork-Ranger Station	47*	181	12	---	---	---
Thompson Falls-Sanders County Courthouse	72	358	260	81	388	370
Polson-MAL	35*	110	104	---	---	---
Ronan-Ninepipes	12*	58	43	---	---	---
Missoula-HW #1	26	80	69	22	94	92
Missoula-HW #2	24	143	101	20	102	99
Missoula-Courthouse Roof	57	316	313	60	301	270
Missoula-Meadow Hills	62*	139	111	37	196	148
Missoula-Spurgin & Tower	45*	125	112	33	147	127
Missoula-Rose Park	50	422	346	54	294	264
Missoula-Northside	58*	180	171	---	---	---
Missoula-Boyd Park	69	366	336	56	440	408
Missoula-Lolo	41*	150	137	---	---	---
Hamilton-Ravalli Co.Crths.	---	---	---	49	267	185
Ovando-Terry Smith Ranch	12	68	57	15	231	145
Deer Lodge-Powell Co. Courthouse	---	---	---	43*	109	87
Anaconda-Lincoln School	36	123	121	35	210	145
Anaconda-Highway Jct.	---	---	---	30*	825	480
Butte-Dr. Canty	43*	187	161	---	---	---
Butte-Hebgen Park	56*	222	192	---	---	---
Butte-Greeley School	50	229	224	43	193	180
Dillon-Bvhd. Co. Crthse.	---	---	---	38*	57	54
Helena-Capital Courts	58	232	212	46	122	116
Helena-Townsend Ave.	43*	119	81	---	---	---
Helena-Cooney Home	33	147	128	33	98	79
Helena-Cogswell Bldg.	40	193	165	42	248	120
E.Helena-Schneider Res.	36*	88	69	---	---	---
E.Helena-Dartman Field	40*	98	95	41	174	114
E.Helena-Hadfield	65	240	232	70	326	301
E.Helena-Firehall	65	142	136	66	216	206
E.Helena-Hastie	53	135	132	52	141	115
E.Helena-Dudley Street	41*	90	78	---	---	---
E.Helena-South	31	90	76	34	98	94

TABLE 8, Continued

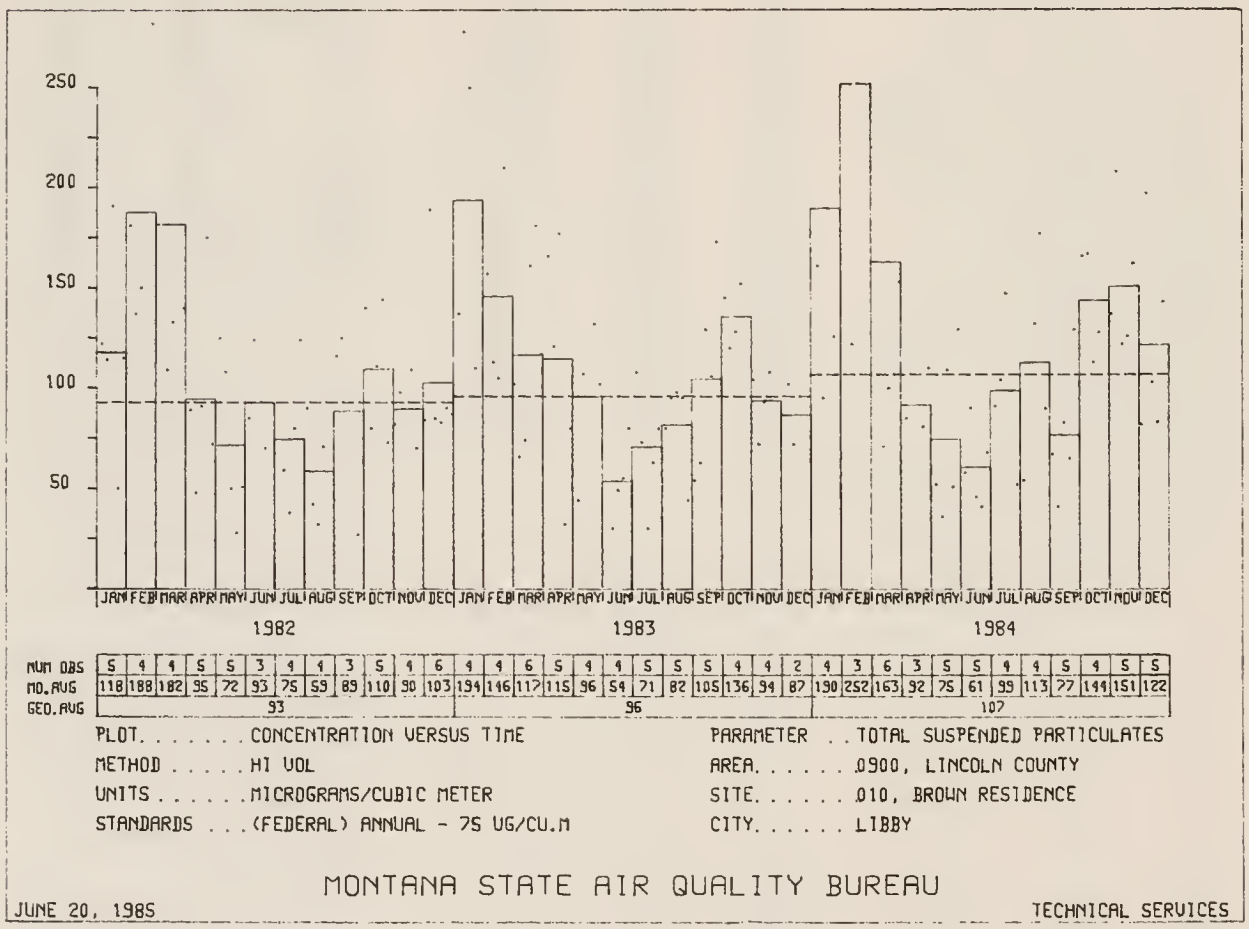
SUMMARY OF TSP CONCENTRATIONS AT MONTANA SAMPLING LOCATIONS

	1983			1984		
	Geo. Mean ug/m^3	1-High ug/m^3	2-High ug/m^3	Geo. Mean ug/m^3	1-High ug/m^3	2-High ug/m^3
Montana City-School	67*	193	175	78	349	201
Great Falls-Downtown	42	108	105	46	120	93
Great Falls-Fire Station	49	163	112	63	175	174
Great Falls-Franklin Sch.	43	104	91	34*	78	70
Black Eagle-Post Office	55	201	171	56	175	134
Bozeman-East Main	56	265	180	69	198	179
Bozeman-Whittier School	47	118	114	57	202	157
Havre-Central Building	49*	174	147	---	---	---
Malta-Bowdoin	17*	44	42	13	60	55
Lewistown-Downtown	34*	93	45	---	---	---
Laurel-Jr. High	35	81	59	37	107	92
Billings-Grand Avenue	51	148	143	58	138	106
Billings-City Hall	55	152	127	63	143	133
Billings-Taft School	56	217	207	69	191	163
Billings-Lockwood School	38*	60	52	---	---	---
Billings-Lockwood Park	60*	293	186	53	187	153
Billings-Sandstone Sch.	28	76	61	30	108	81
Scobey-Border	9*	58	50	16*	54	48
Scobey-Richardson	11*	233	54	17*	114	62
Scobey-Hanrahan	11*	108	56	19*	89	84
Jordan-Billings Ranch	13*	43	41	4*	9	6
Sidney-Downtown	51*	116	96	68	233	155
Glendive-Med. Arts Bldg.	24*	60	58	29	72	69
Miles City-PCA	50*	187	125	---	---	---
Plevna-BLM	23*	121	107	32*	60	54

*Less than eight months of data

5. Despite recent improvements, Libby still registers some of the highest TSP levels in the state. During 1984, the Brown Residence site recorded the highest geometric mean (107 ug/m^3) for total suspended particulate in the entire state. A twenty-four hour reading of 378 ug/m^3 was also among the highest concentrations recorded in 1984. Particulate concentrations at the Brown Residence exceeded both Montana and federal primary standards for annual average and twenty-four hour average. Figure 11 is a plot of monthly TSP concentrations for the last three years.

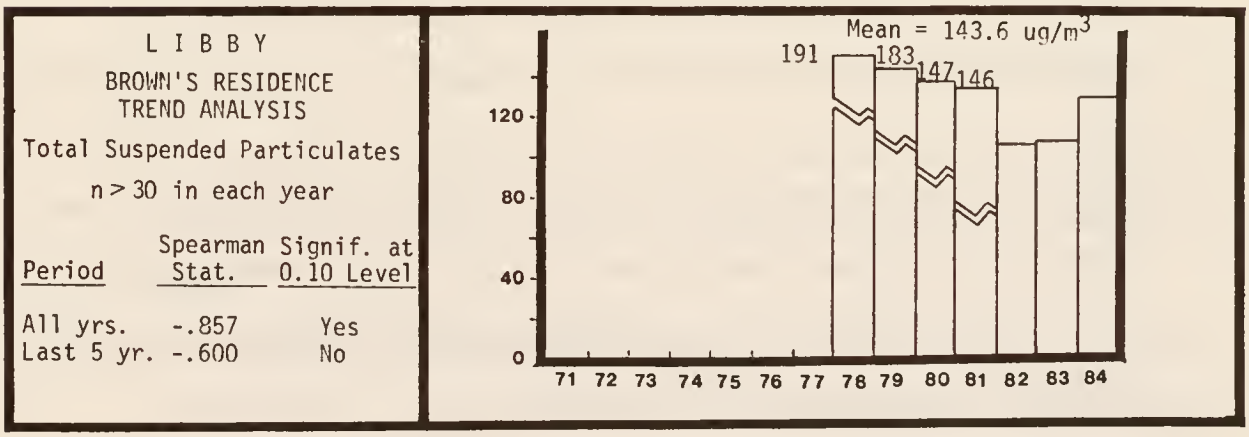
FIGURE 11


250
200
150
100
50
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1982
1983
1984
NUM OBS 5 4 4 5 5 3 4 4 3 5 4 6 4 4 6 5 4 4 5 5 5 4 4 2 4 3 6 3 5 5 4 4 5 4 5 5
MO.AVG 118 188 182 95 72 93 75 59 89 110 90 103 194 146 117 115 96 54 71 82 105 136 94 87 190 252 163 92 75 61 99 113 77 144 151 122
GEO.AVG 93 96 107
PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M
PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0900, LINCOLN COUNTY
SITE. . . . . 010, BROWN RESIDENCE
CITY. . . . . LIBBY
MONTANA STATE AIR QUALITY BUREAU
JUNE 20, 1985
TECHNICAL SERVICES

6. The department has monitored TSP at the Brown Residence in Libby since late 1977. Figure 12 graphically displays the annual arithmetic means for the entire period. The department performed a trend analysis on the data from the Brown Residence and Figure 12 also displays those results. The analysis indicated a statistically significant downward trend for the seven year history of the site.

A similar analysis performed on the last five years of data indicated a decrease in TSP levels, but the decline was not statistically significant. The most likely reason for the reduction in TSP levels is the completion of a major highway improvement project which repaved, curbed and guttered the entire length of U.S. Highway 2 through town. Completion of this project along with improved street cleaning and maintenance undoubtedly reduced fugitive dust emissions. Two other actions may also have contributed to lower TSP concentrations: (1) the Champion

FIGURE 12



International sawmill and plywood plant installed air pollution control equipment on their hog fuel boilers during 1978 and (2) the department and the Montana Division of Forestry significantly improved the Montana Smoke Management Plan during 1979 and 1980.

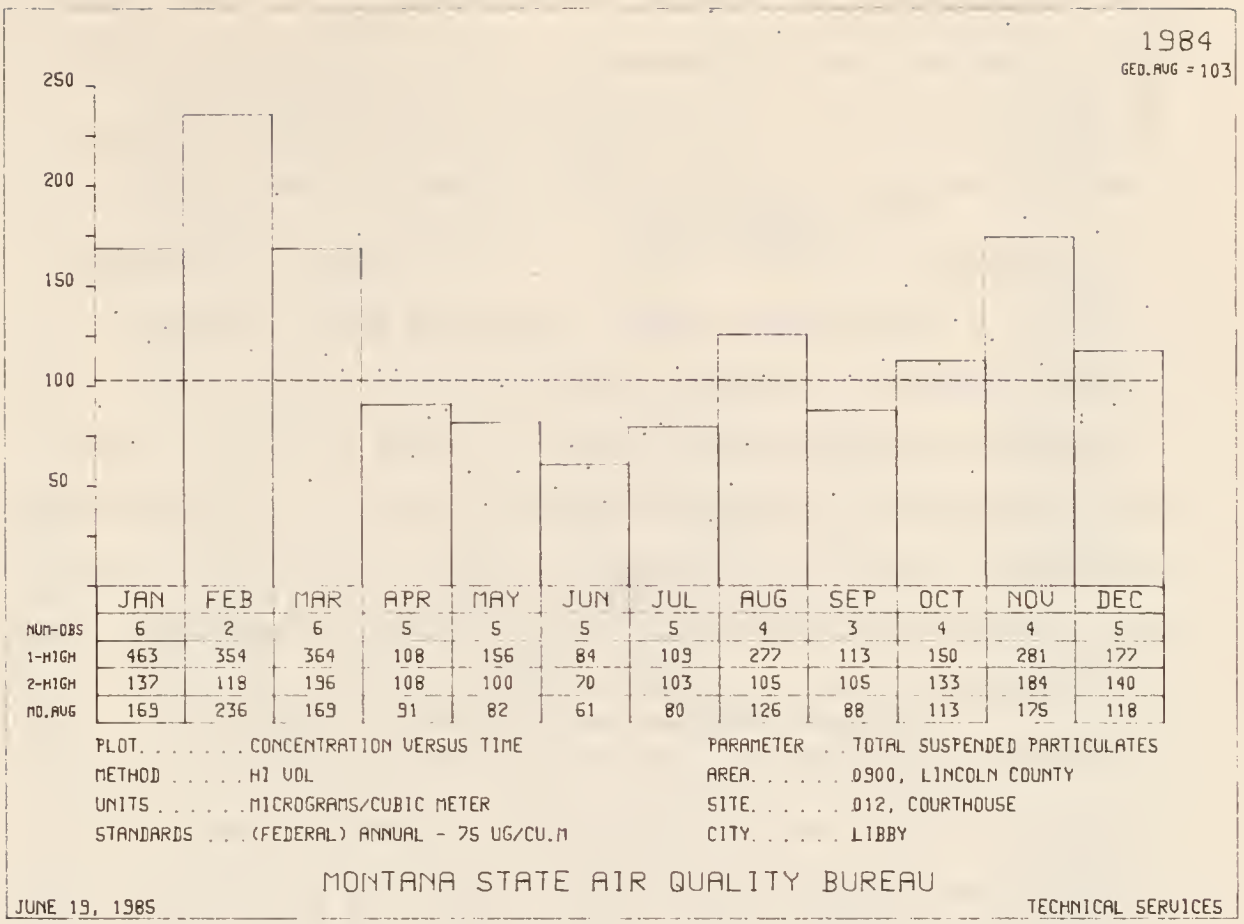
7. The department has operated a high volume sampler on the roof of the Lincoln County Courthouse since January, 1983. This site is the primary sampling site in Libby and was upgraded to a collocated site in July, 1984. The Courthouse site is located in the downtown area of Libby one and one-half blocks west of Main Street. The street immediately to the east of the site is Highway 37 and provides the only access to the north side of the Kootenai River. The samplers are approximately 40 feet above ground level and near the center of the block. Except for the Courthouse building itself, the remainder of the block is in lawn.

8. TSP concentrations at the Lincoln County Courthouse are very high and show similar patterns to those at the Brown Residence. The Courthouse site recorded the second highest annual geometric mean (103 ug/m^3) within Montana during 1984. It also recorded the second highest individual sample at 463 ug/m^3. Data from this site exceeded all Montana and federal ambient standards during 1984. Figure 13 is a plot of 1984 TSP data.

9. In light of the high TSP levels observed in Libby, the department initiated a special project during the winter of 1984 to better quantify the air quality and identify the contributing emission sources. The project was designed to achieve three objectives:

   a. To determine the source or sources of high TSP levels in Libby and the size distribution of the particles;

FIGURE 13


1984
GEO.AVG = 103
250
200
150
100
50
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
NUM-OBS 6 2 6 5 5 5 5 4 3 4 4 5
1-HIGH 463 354 364 108 156 84 109 277 113 150 281 177
2-HIGH 137 118 196 108 100 70 103 105 105 133 184 140
MO.AVG 169 236 169 91 82 61 80 126 88 113 175 118
PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M
PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0900, LINCOLN COUNTY
SITE. . . . . 012, COURTHOUSE
CITY. . . . . LIBBY
MONTANA STATE AIR QUALITY BUREAU
JUNE 19, 1985
TECHNICAL SERVICES

b. To determine if automobile and wood stove emissions can cause elevated carbon monoxide levels in a small western Montana community; and

c. To identify any relationships between carbon monoxide, scattering coefficient, fine particulates, and total suspended particulates.

In order to accomplish the first objective, the department decided to utilize a receptor model known as the "Chemical Mass Balance" technique (CMB). CMB requires a multi-element chemical analysis of the emissions

from the suspected sources in the study area as well as the ambient samples collected. The elemental composition of the emissions essentially provides a source "fingerprint." Since the total mass of each element on the filter must equal the sum of the elemental contribution from each source, a series of equations can be developed and solved simultaneously in a computer program. The department also performed analyses for organic and inorganic carbon since many of the local emission sources are combustion sources.

The emissions sources sampled in Libby are listed in Table 9. Some source samples were collected on filter media which allows direct elemental analysis. Bulk source samples were dried, sieved to less than 400 mesh (39 microns), and resuspended onto filter media. Department personnel gathered the source samples during January and February, 1984. The ambient sampling consisted of three high volume samplers located on the roof of the Lincoln County Courthouse and a dichotomous sampler with a 15 micron sampling head located one-half block away at the Wrecking Yard site. Each of the high volume samplers on the Courthouse utilized different filter media designed to obtain different types of data as specified in Table 10.

The department completed the collection of ambient and source samples during August, 1984. The department contracted with an environmental laboratory to perform the chemical analysis and the subsequent computerized CMB analysis. The department expects to receive the results by August 15, 1985.

TABLE 9

LIBBY SOURCE SAMPLES

Sample[a,b] No.	Sample	Collection Date
1	State Sandpile East of Libby	1/19/84
1A	State Sandpile East of Libby (split)	1/19/84
2	State Sand Shed East of Libby	1/19/84
2A	State Sand Shed East of Libby (split)	1/19/84
3	St. Regis Plt - Road Dust - Crossroad Near Office	2/28/84
3A	St. Regis Plt - Road Dust - Crossroad Near Office (split)	2/28/84
4	County Sandpile Northwest of Libby	1/19/84
4A	County Sandpile Northwest of Libby (split)	1/19/84
5	City Sandpile Shed Near River	1/19/84
5A	City Sandpile Shed Near River (split)	1/19/84
6[c]	St. Regis Plt #9 Boiler Multicone Catch	1/19/84
6A	St. Regis Plt #9 Boiler Multicone Catch (split)	1/19/84
7	St. Regis Plt #8 Boiler Scrubber Catch	1/19/84
7A	St. Regis Plt #8 Boiler Scrubber Catch (split)	1/19/84
8[c]	St. Regis Plt #9 Boiler Scrubber Catch	1/19/84
8A	St. Regis Plt #9 Boiler Scrubber Catch (split)	1/19/84
9[d]	Snow Sample Collected Near St. Regis Plt	1/84
10	Road Dust, Mineral and West Fifth	2/28/84
10A	Road Dust, Mineral and West Fifth (split)	2/28/84
11[c]	St. Regis Plt, Road Dust, Logging Road from Libby Creek at Entrance to the Plant	2/28/84
11A	St. Regis Plt, Road Dust, Logging Road from Libby Creek at Entrance to the Plant (split)	2/28/84
12	St. Regis Plt #7 Boiler Multicone Catch	1/19/84
12A	St. Regis Plt #7 Boiler Multicone Catch (split)	1/19/84
13	Road Dust, Vacuum Sample, Main Avenue & Fifth	2/28/84
13A	Road Dust, Vacuum Sample, Main Ave. & Fifth (split)	2/28/84
14[c]	Road Dust, Fifth and Idaho	2/28/84
14A	Road Dust, Fifth and Idaho (split)	2/28/84
15	Road Dust, Main Avenue and Sixth	2/28/84
15A	Road Dust, Main Avenue and Sixth (split)	2/28/84
16[c]	St. Regis Plt, Sander Dust	1/19/84
16A	St. Regis Plt, Sander Dust (split)	1/19/84
17	Road Dust, California and Fifth	2/28/84
17A	Road Dust, California and Fifth (split)	2/28/84
18	Road Dust, Main Avenue and Fifth, on Main	2/28/84
18A	Road Dust, Main Avenue & Fifth, on Main (split)	2/28/84
19	Road Dust, Main and Fourth	2/28/84
19A	Road Dust, Main and Fourth (split)	2/28/84
20[c]	W.R. Grace Co. Bagging Plt, Baghouse Catch (in town)	2/28/84
21	Libby, St. Regis Plt, South Veneer Dryer (Fiberglass Back), 65/72 min	2/28/84
22	Libby, St. Regis Plt, South Veneer Dryer (Fiberglass Back), 55/40 min	2/28/84

a All samples except 7, 7A, 8, 8A, 9, 21, and 22 were screened to pass a 400 mesh screen.
b All samples except #9 are being resuspended on dichotomous filters.
c These samples are also being resuspended on high volume filters.
d Not being processed at this time.

TABLE 10

FILTER MEDIA FOR LIBBY STUDY

	Media	Objective	Advantage
a.	Fiberglass	Determine TSP	Federal & Montana reference method for TSP.
b.	Teflon	Determine elemental concentrations	Low elemental background in filter media and smooth filter surface. Excellent for X-ray fluorescent analysis.
c.	Fired quartz	Determine organic and inorganic carbon	Low carbon background in filter media.

The department has completed its analysis of the particle size distribution for the Libby airshed. Table 11 summarizes the results. The department operated the dichotomous sampler at the Wrecking Yard site from January 20, 1984, to March 31, 1984. Thirteen pairs of samples were collected. The average concentrations for the <2.5 micron, 2.5 to 15 micron, and <15 micron size groups were 67.6 ug/m^3, 86.5 ug/m^3, and 154.1 ug/m^3, respectively. The Environmental Protection Agency is proposing a new particulate standard for particles less than 10 microns in diameter. The standard will be set at an annual mean concentration in the range of 50-65 ug/m^3. It is obvious that Libby will not meet the proposed standard just as it does not meet the present TSP standards.

Since the proposed standard addresses only those particulates which penetrate deep into the human lung, it is very important that the department complete the Libby study and begin to design and implement the appropriate control strategies. The department also installed a collocated PM-10 monitor at the Lincoln County Courthouse in May, 1985.

TABLE 11

PARTICLE SIZE DISTRIBUTION OF TSP
AT THE LIBBY WRECKING YARD SITE

Date	Back Scatter*	Concentration by Particle Size Group** <2.5 micron	2.5-15 micron	<15 micron	Total Susp. Particulate
1/20/84	----	52.9	15.4	68.3	---
1/25/84	63.0	94.9	9.9	104.8	129
1/31/84	54.8	90.6	284.2	374.8	463
2/6/84	66.0	87.6	127.3	214.9	---
2/12/84	69.2	83.5	7.7	91.2	---
2/18/84	62.1	71.3	248.1	319.4	354
2/24/84	50.3	60.2	22.5	82.7	118
3/1/84	51.9	85.1	83.3	168.4	196
3/7/84	54.7	91.4	175.5	266.9	364
3/13/84	27.5	30.6	3.5	34.1	53
3/19/84	28.8	41.4	57.2	98.6	116
3/25/84	34.5	43.3	24.8	68.1	108
3/31/84	36.2	46.4	65.2	111.6	176
		$\bar{X}$ = 67.6	86.5	154.1	207.7
		$\bar{X}_T$ = 65.5	97.4	162.9	

SUMMARY

<15u = 78.4% of TSP
<2.5u = 31.5% of TSP
<2.5u = 43.9% of RSP (15u)

*Twenty-four hour averages expressed in units of per meter
**All concentrations are in micrograms per cubic meter
$\bar{X}$ = the mean for all samples
$\bar{X}_T$ = the mean for all samples except samples for 1/20/84, 2/6/84 and 2/12/84

10. The department performed linear regression analyses to compare each of the different particle size categories and the nephelometer data with each other (Table 12). The comparisons involved data collected between January 1, 1984 and March 31, 1984. The nephelometer measures the amount of light which is scattered backwards by fine particulates or visible gases. Figure 14 shows the relationship between particle size and the

TABLE 12

CORRELATION COEFFICIENTS BETWEEN BACK-SCATTER AND VARIOUS SIZE CLASSES OF PARTICULATES FROM LIBBY MONITORING SITES

	Back-scatter	<2.5 microns	2.5-15 microns	<15 microns	TSP
Back-scatter	----	0.888 (12)	0.332 (12)	0.484 (12)	0.553 (14)
<2.5 microns	0.888 (12)	----	0.464 (13)	0.662 (13)	0.660 (10)
2.5-15 microns	0.332 (12)	0.464 (13)	----	0.982 (13)	0.971 (10)
<15 microns	0.484 (12)	0.662 (13)	0.982 (13)	----	0.987 (10)
TSP	0.553 (14)	0.660 (10)	0.971 (10)	0.987 (10)	----

NOTE: 1. TSP data was collected at the Lincoln County Courthouse while Back-scatter and the particle size data was collected at the nearby Wrecking Yard site.

2. Parentheses denote the number of data pairs.

FIGURE 14

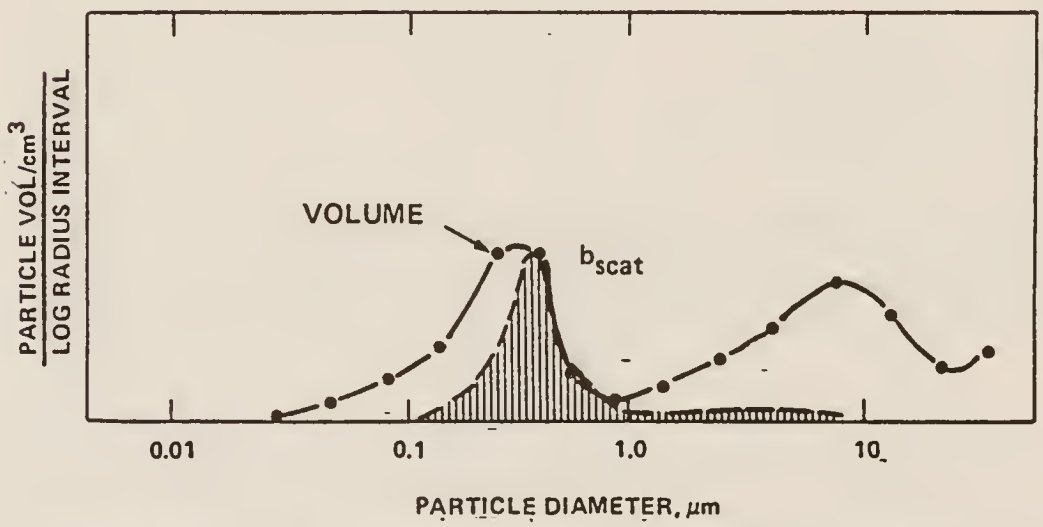


Figure 2-19 For a typical aerosol volume (mass) distribution, the calculated light scattering coefficient is contributed almost entirely by the size range 0.1 1.0 μm. The total b_{scat} and total aerosol volume are proportional to the area under the respective curves (Charlson et al., 1978).

amount of light which is back-scattered. Particles with diameters between 0.1 and 1 micron account for over 95 percent of the back-scattered light. Therefore, it is not surprising that a very good correlation (r = 0.888) was observed between the less than 2.5 micron particulates and the associated twenty-four hour nephelometer readings. The correlations between the larger particle sizes and the nephelometer were poor at best.

The department also compared the various size classes of particulates with each other and obtained predictable results. The best correlation (r = 0.987) was observed between the <15 micron class and TSP. Since the <15 micron category made up 78.4% of the TSP during the study period, a good correlation was expected. The 2.5 to 15 micron class made up 46.9% of the TSP catch and correlated with TSP very well (r = 0.971). On the other hand, the <2.5 micron category comprised only 31.5% of the TSP and displayed only a fair correlation with TSP. The poorest correlation between size classes was between the <2.5 micron and the 2.5 to 15 micron category (r = 0.464). This relationship seems to indicate that the sources of fine particulate and coarse particulate in Libby are not the same. The department speculates that residential wood burning and the wood products industries are the primary sources of fine particulate and re-entrained road dust is a significant contributor to the coarse fraction. This contention is reinforced by the fact that during the sieving of the road dust samples (sample size = approximately 2 liter), the department had difficulty obtaining a 25 ml sample of dust in the <400 mesh category. This was a consistent phenomenon while sieving over 18 separate samples. In addition, the preliminary indications from the

contractor performing the sample resuspensions show that of the material <39 microns, almost none of it is being collected on the <2.5 micron dichotomous filter.

11. The remaining objectives of the Libby study are addressed later in this report under the sections addressing carbon monoxide and visibility.

12. The department intends to operate the Lincoln County Courthouse site indefinitely. The site will continue to quantify TSP levels in Libby and in the future it will track the effectiveness of any control strategies which are implemented. In addition, the department installed a collocated PM-10 sampler at the Courthouse in May, 1985.

Eureka

1. Eureka is a small town (pop. 1100) in northwestern Montana. The town is situated in some rolling hills along the Tobacco River approximately five miles upstream from Lake Koocanusa. A broad flat valley stretches to the north for ten miles to the Canadian Border.

2. In accordance with the 1984 Network Review, the department installed a TSP monitoring site at the Lincoln Electric Cooperative. The site is located approximately 150 feet south of U.S. Highway 93 at the point where it turns north to become Main Street. The city slopes gently to the south toward the monitoring site. Since the site is near the south edge of town, downslope winds during the night may carry particulate emissions from the entire town toward the site. The immediate area around the site is grassy. A large empty warehouse lies to the south and the Tobacco River is just beyond that. The department began sampling at this location during May, 1984.

3. Figure 15 shows the location of the Eureka site. The associated TSP data is summarized in Table 8.

4. The department collected eight months of TSP data during 1984. The geometric mean was 64 ug/m^3. The highest individual readings were 349 ug/m^3 and 276 ug/m^3. These twenty-four hour concentrations exceeded the Montana and federal primary ambient standards and were among the highest concentrations recorded within Montana.

5. In light of the high concentrations, the department intends to continue to operate the Eureka site.

Thompson Falls

1. Thompson Falls is a small town of 1500 people situated on the north side of the Thompson Falls Reservoir. The reservoir is a small impoundment on the Clark Fork River. The Clark Fork River valley near Thompson Falls runs east and west, with mountains rising to 7000 feet on the north and south. As with all western Montana valleys, Thompson Falls experiences severe temperature inversions during the fall and winter.

2. Figure 16 is a map of Thompson Falls showing the location of the sampler. Table 8 lists the associated TSP data.

3. The Thompson Falls sampler is located on the roof of the Sanders County Courthouse. During 1984, the Courthouse site recorded a geometric mean for TSP of 81 ug/m^3. This concentration is above the Montana and federal primary standards of 75 ug/m^3 and was the fourth highest geometric mean recorded in Montana. The 1984 mean was 12 percent higher than the 1983 mean. The highest twenty-four hour concentrations were 388 ug/m^3 and 370 ug/m^3. These values are also above the state and federal primary standards.

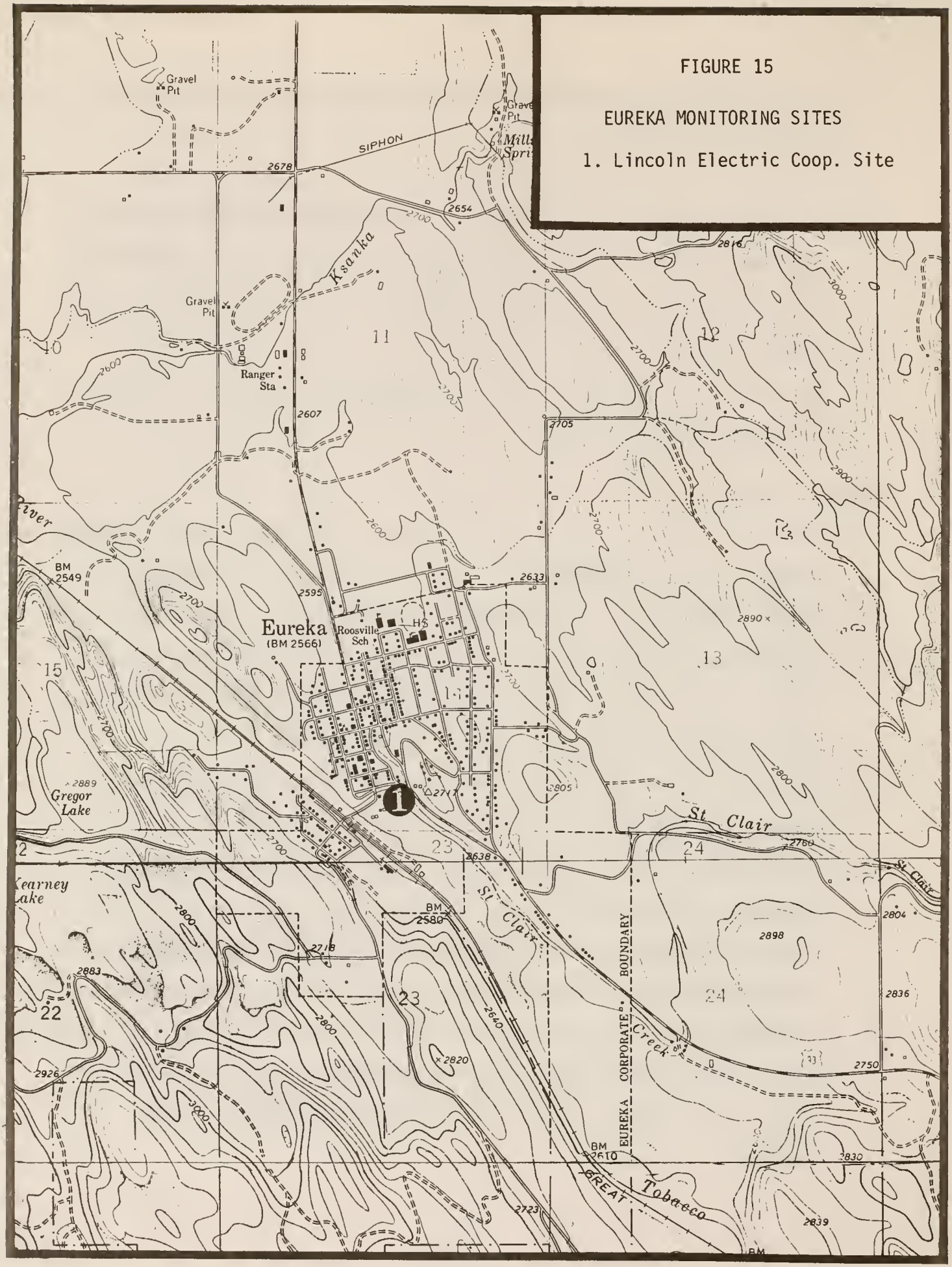


FIGURE 15

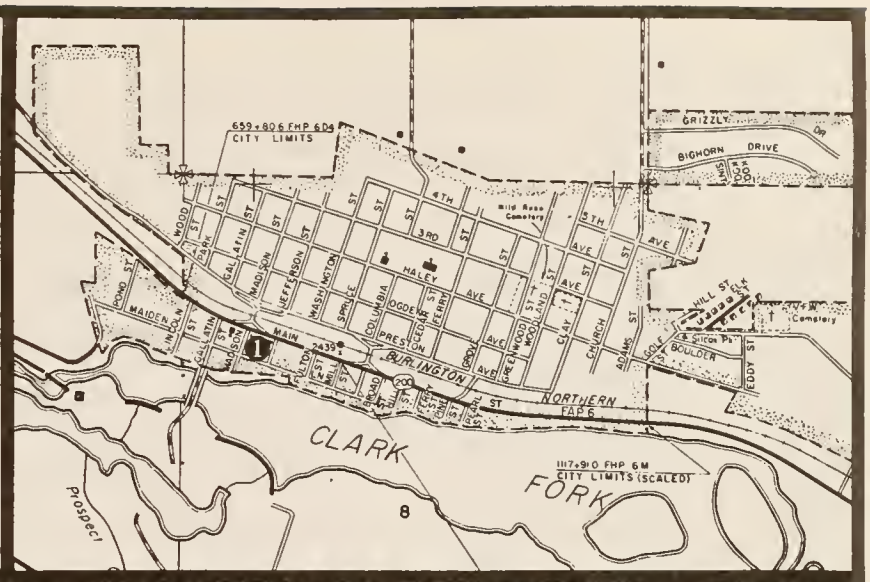
EUREKA MONITORING SITES

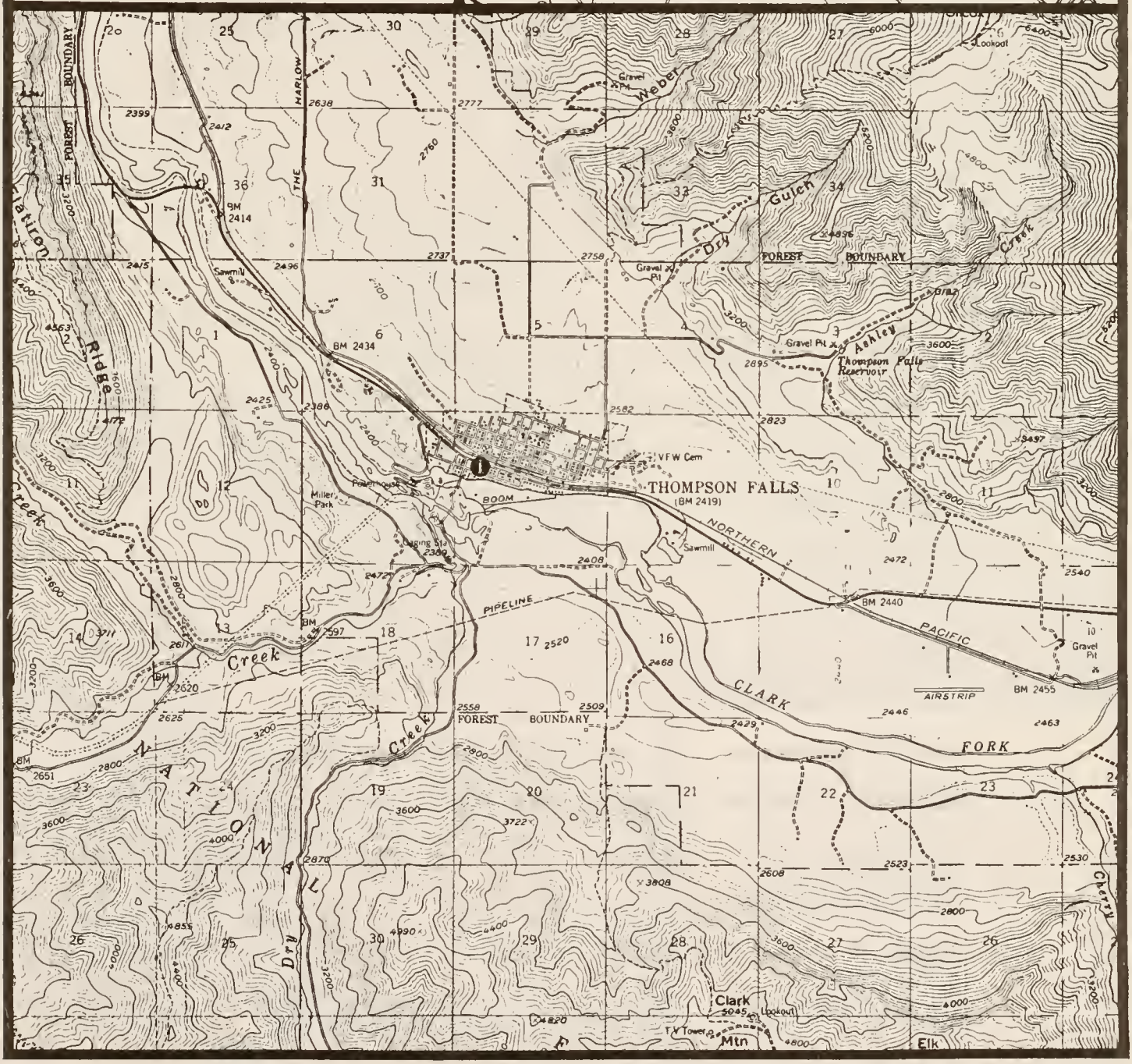
1. Lincoln Electric Coop. Site

FIGURE 16

THOMPSON FALLS MONITORING SITES

1. Sanders County Courthouse site





4. The Thompson Falls area obviously has an air quality problem. The most likely causes are residential wood burning, re-entrained road dust, and emissions from a nearby sawmill. The department is in the process of completing a source apportionment study in Libby, designing one for Kalispell, and considering one for Bozeman. Depending on the results of these studies, the department may initiate similar studies in Butte and Thompson Falls. Even without a community-specific study in Thompson Falls, the results in the other areas may demonstrate a need for a regionwide control strategy. If Thompson Falls is similar to other western Montana communities and regionwide controls are enacted, Thompson Falls may share the benefits.

4. The department will continue to monitor for TSP in Thompson Falls and has also just recently installed a PM-10 monitor at the Courthouse site.

Kalispell

1. Kalispell is the commercial center of the Flathead Valley. The city has a population of approximately 10,000 people with perhaps an additional 10,000 people living within three miles of the city limits. The Flathead Valley is predominantly agricultural; however, subdivisions have made inroads into the agricultural land base over the past 10 years. The mountains, lakes, and streams in the area also attract large numbers of tourists. The Big Mountain ski resort 20 miles north of Kalispell makes the area a year-round vacation destination.

   The high mountains to the east tend to block the prevailing west winds, resulting in decreasing precipitation moving toward the west and very light valley winds. Temperature inversions are prevalent during the fall and winter months.

2. Figure 17 locates the Kalispell monitoring sites and Table 8 summarizes the associated data.

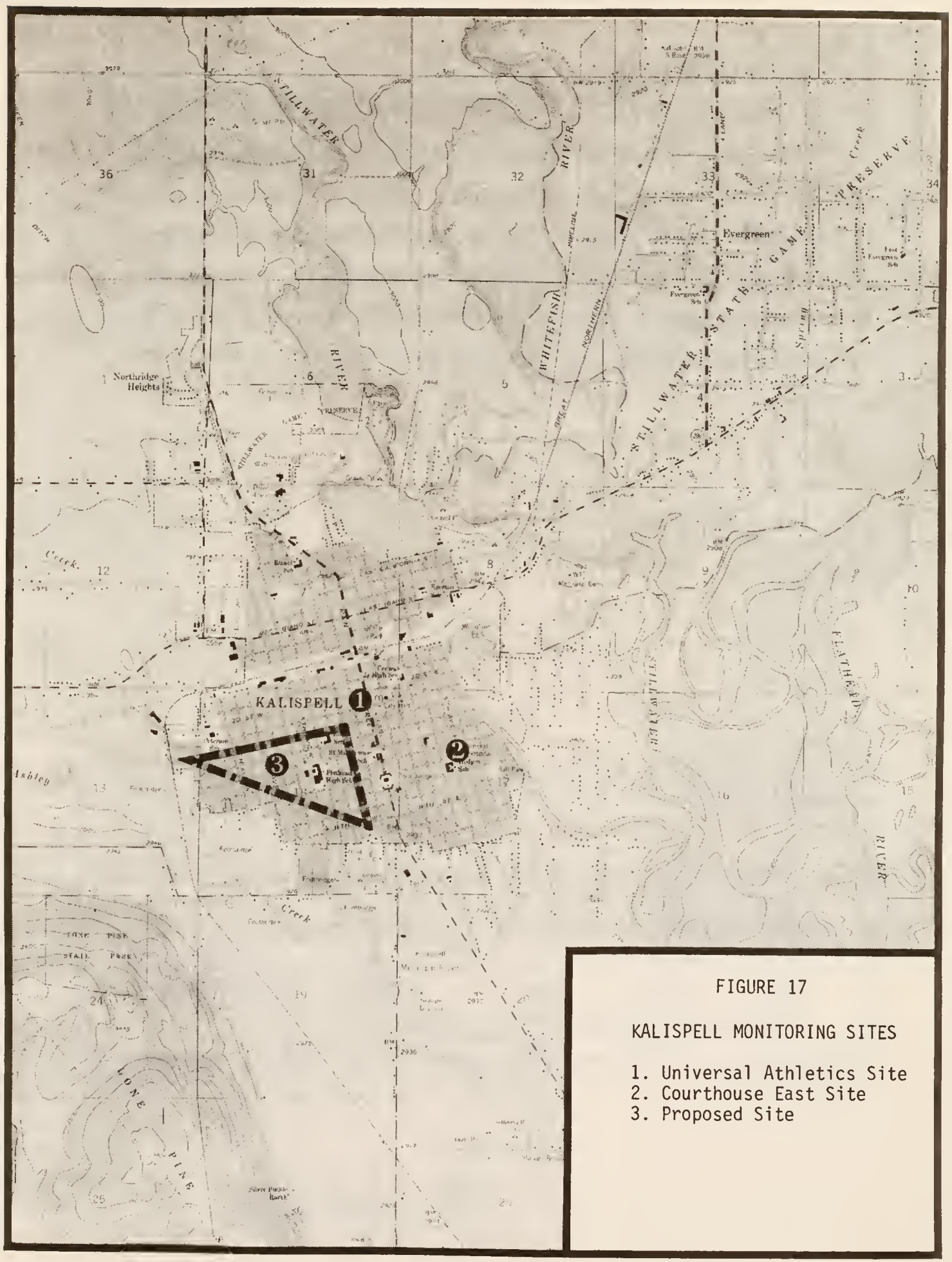


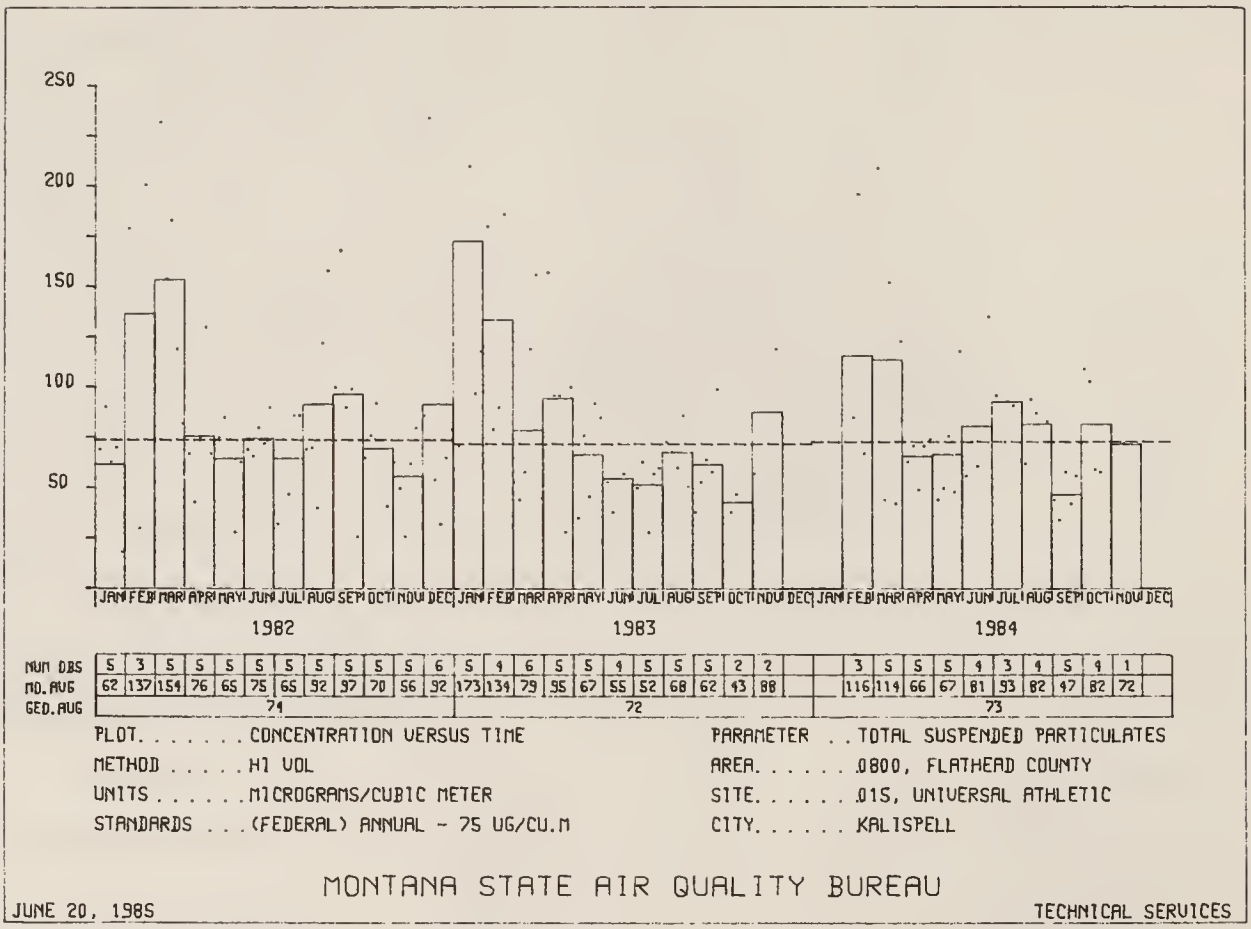
FIGURE 17

KALISPELL MONITORING SITES

1. Universal Athletics Site
2. Courthouse East Site
3. Proposed Site

3. The Universal Athletics site is located in the downtown area of Kalispell and has operated for five years. In 1984, the geometric mean for TSP decreased 3 percent to 70 ug/m^3. The highest twenty-four hour concentration was 209 ug/m^3. This concentration was substantially lower than the highest concentration in 1983. In 1984, the data from the site complied with state and federal primary standards but exceeded federal secondary ambient standards. Figure 18 is a three-year plot of monthly TSP concentrations at the Universal Athletics site.

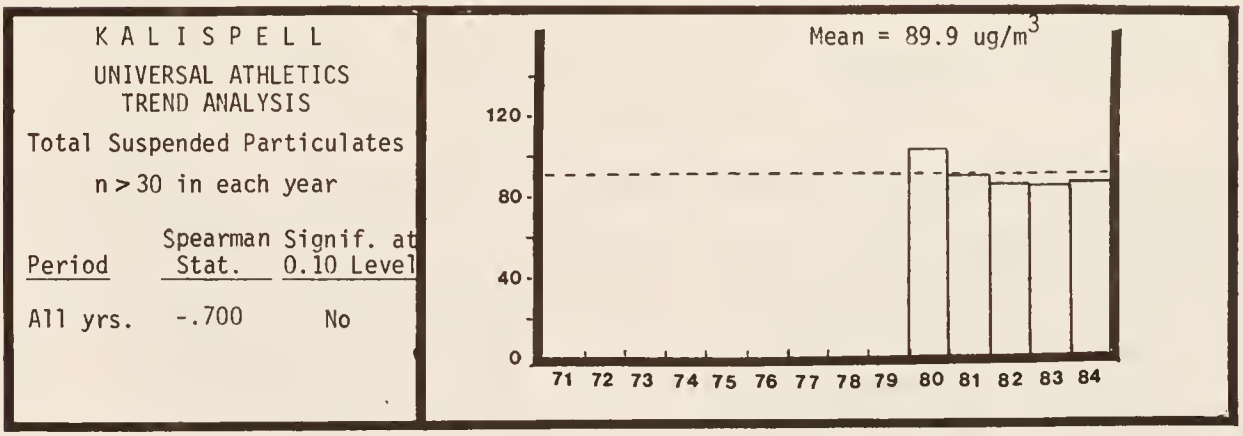
FIGURE 18


250
200
150
100
50
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1982
1983
1984
NUM OBS 5 3 5 5 5 5 5 5 5 5 5 6 5 4 6 5 5 4 5 5 5 2 2 3 5 5 5 4 3 4 5 4 1
MO. AVG 62 137 154 76 65 75 65 92 97 70 56 92 173 134 79 95 67 55 52 68 62 43 88 116 114 66 67 81 93 82 97 82 72
GED. AVG 74 72 73
PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M
PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0800, FLATHEAD COUNTY
SITE. . . . . 01S, UNIVERSAL ATHLETIC
CITY. . . . . KALISPELL
MONTANA STATE AIR QUALITY BUREAU
JUNE 20, 1985
TECHNICAL SERVICES

4. The department conducted a trend analysis (see Figure 19) for the past five years of data from the Universal Athletics site. The trend analysis shows a decrease in particulate levels but the decline was not statistically significant.

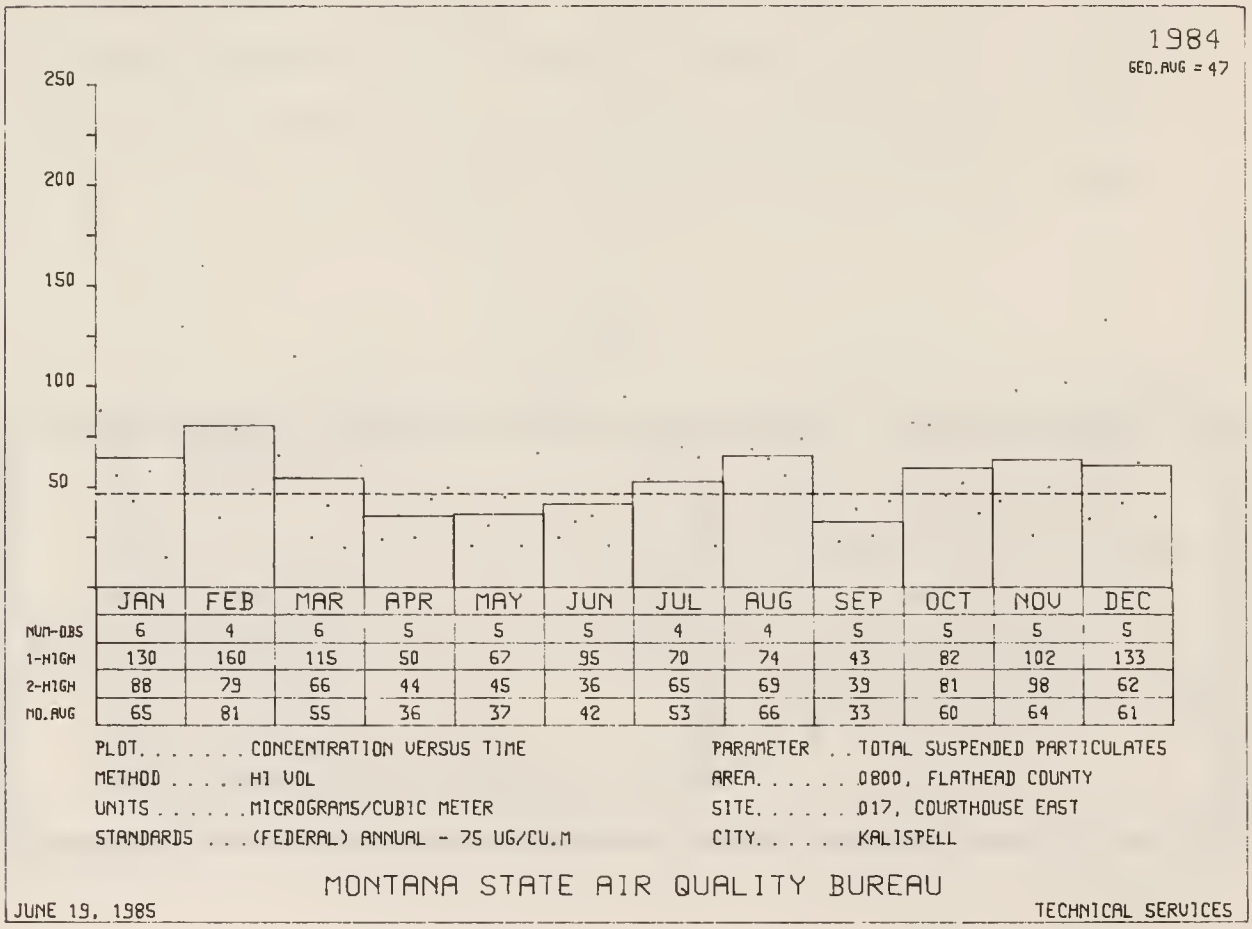
5. The department plans to continue routine TSP sampling at the Universal Athletics site indefinitely. PM-10 monitoring was initiated during May, 1985. In addition, the department intends to conduct a detailed source apportionment study in Kalispell during late 1985 and most of 1986. The study will require two additional high volume samplers and two dichotomous samplers to be located at the Universal Athletics site. These samplers will be necessary because the sampling will utilize teflon, quartz and fiberglass filter media. The study will include source sampling to establish chemical "fingerprints" of the various sources and utilize the chemical mass balance technique. A draft protocol of the study is available at the department's Helena office.

FIGURE 19



6. The department established a TSP sampling site at the Courthouse East Annex in Kalispell during January, 1983. The 1984 geometric mean for total suspended particulates increased 4 percent over the 1983 level. However, particulate concentrations are still relatively low at this site with a geometric mean of 47 ug/m^3 and a twenty-four hour high of 160 ug/m^3. During 1984, the data complied with all state and federal ambient standards. The department shut down the Courthouse East site in January, 1985, due to the low TSP concentrations. Figure 20 is a plot of 1984 monthly TSP concentrations at the Courthouse East site.

FIGURE 20



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	6	4	6	5	5	5	4	4	5	5	5	5
1-HIGH	130	160	115	50	67	95	70	74	43	82	102	133
2-HIGH	88	79	66	44	45	36	65	69	39	81	98	62
NO.AVG	65	81	55	36	37	42	53	66	33	60	64	61

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0800, FLATHEAD COUNTY
SITE. . . . . 017, COURTHOUSE EAST
CITY. . . . . KALISPELL

MONTANA STATE AIR QUALITY BUREAU

JUNE 19, 1985 TECHNICAL SERVICES

7. In conjunction with the Kalispell source apportionment study, the department intends to operate two primary monitoring sites. As mentioned earlier, the Universal Athletics site will be the first, while the second location is still to be chosen. The department will attempt to find a location in a residential area on the west side of Kalispell.

Columbia Falls

1. Columbia Falls is an industrial town of 3100 people located in the extreme northeast corner of the Flathead Valley. In the vicinity of Columbia Falls are a plywood-particleboard-sawmill complex, an additional sawmill, and an aluminum reduction plant.

   Wind patterns in the area are dominated by drainage winds through Badrock Canyon and through a gap north of town which drains the north fork of the Flathead River.

2. Figure 21 is a map locating the Columbia Falls monitoring sites. Table 8 summarizes the TSP data from the Anders site.

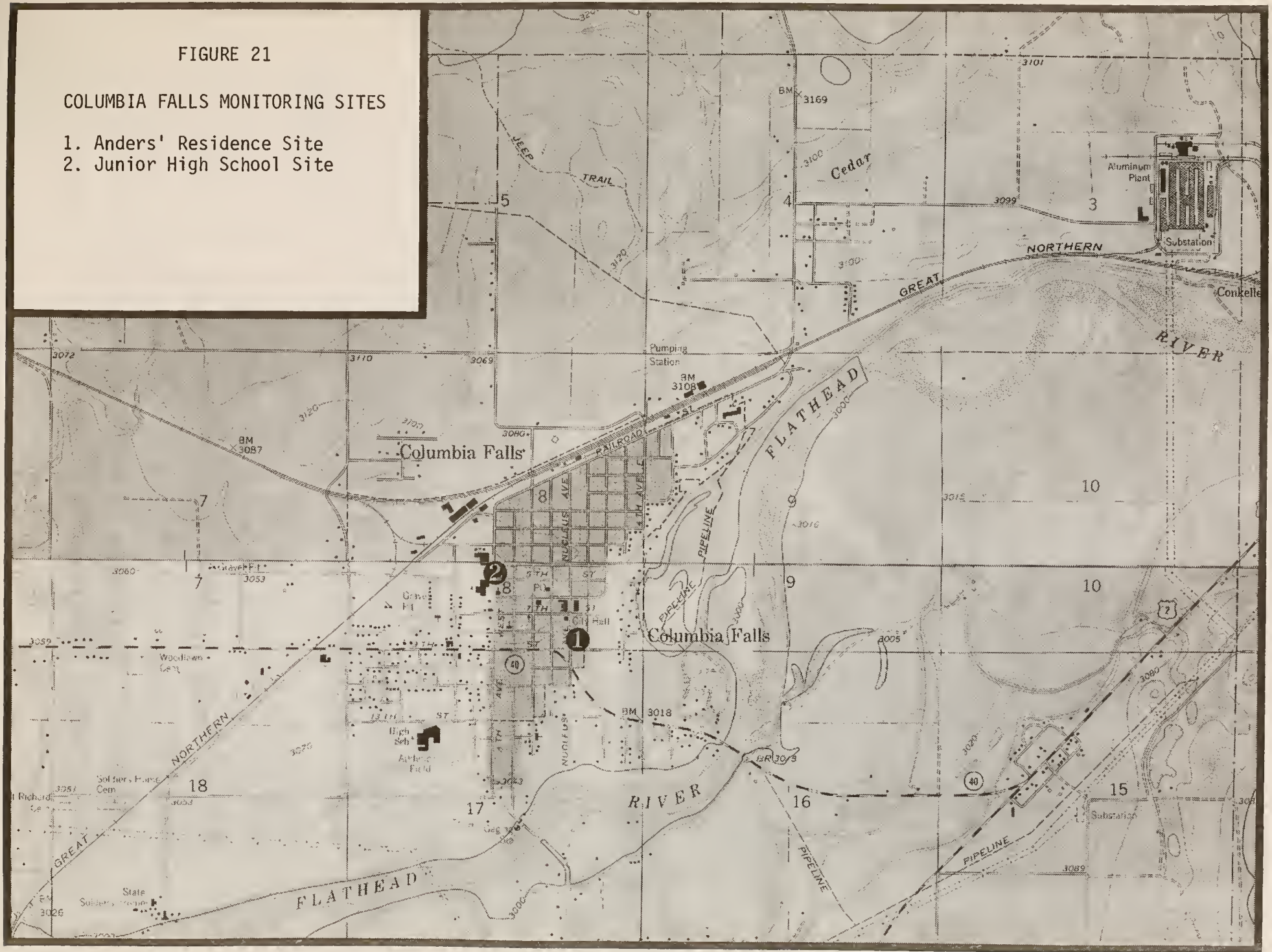
3. The Anders Residence high volume sampler is located on the roof of a garage one block east of Nucleus Avenue. The sampler intake is approximately at the same height as the road surface. This area of Columbia Falls is primarily residential although it is adjacent to the central business district and strip development along Highway 40.

4. The Anders Residence site was responsible for the nonattainment designation of Columbia Falls. A subsequent microinventory conducted in 1979 identified fugitive dust from paved and unpaved streets as accounting for over 90 percent of the TSP. A paving project involving Nucleus Avenue, the main street of Columbia Falls, was completed in 1981. Highway 40 through Columbia Falls was also paved, curbed and guttered during the summer of 1984.

FIGURE 21

COLUMBIA FALLS MONITORING SITES

1. Anders' Residence Site
2. Junior High School Site



5. The 1984 geometric mean for TSP at the Anders site was 91 ug/m^3. This was the third highest geometric mean recorded in Montana during 1984. The first and second highest individual readings of 437 ug/m^3 and 407 ug/m^3 occurred on August 28, 1984, and February 6, 1984, respectively. TSP concentrations at the Anders site exceeded all state and federal standards during 1984.

6. The department performed a trend analysis on the TSP data from the Anders site. The results are displayed graphically in Figure 22. Although the analysis indicated decreasing particulate levels over both the eight year history of the site and the past five years, neither trend was statistically significant.

7. Table 13 describes the total suspended particulate data by season and month of the year. Table 13 further describes the TSP data in relation to the two major construction projects. The highest concentrations occurred in the snow-free months of 1978 through 1981, and 1984. The

FIGURE 22

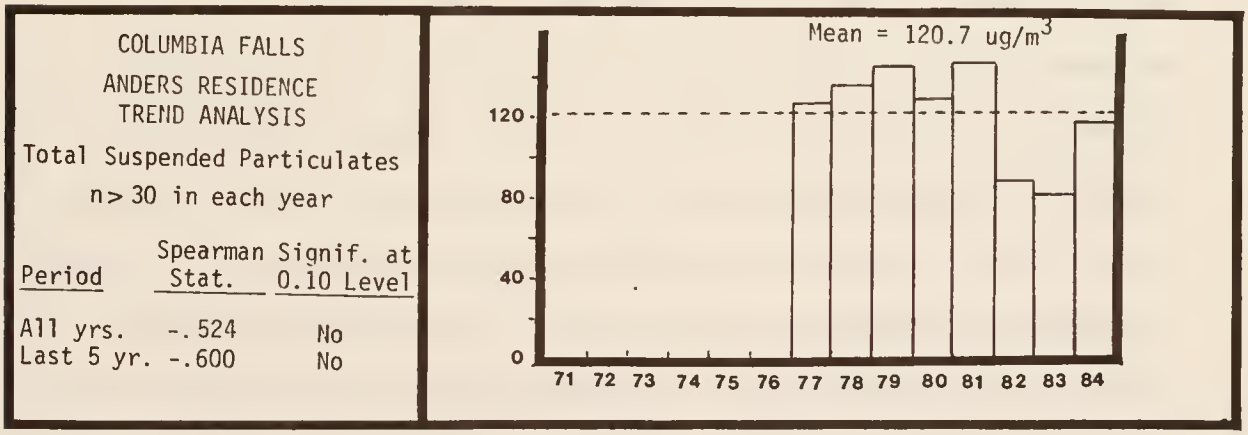


TABLE 13

TSP BY SEASON AND YEAR FROM THE
COLUMBIA FALLS ANDERS RESIDENCE SITE

Year	Total Suspended Particulates (ug/m^3) Jan., Feb., Nov., Dec.	March - Oct.
1978-1980 (Preconstruction)	79 (59)	164 (119)
1981 (Construction Year)	106 (20)	168 (41)
1982-1983 (Nucleus Avenue complete)	69 (38)	89 (81)
1984 (Construction Year)	107 (20)	181 (40)

Note: Parentheses denote the number of samples.

years of 1978 through 1980 were prior to the reconstruction of Nucleus Avenue and, according to the nonattainment analysis, re-entrained road dust was the primary emission source affecting the site. In 1981, Nucleus Avenue was reconstructed and TSP concentrations increased, probably due to fugitive dust from the construction activity. During 1981 and 1982, the concentrations were down considerably, presumably due to the effects of the new street. With the beginning of construction on Highway 40, the 1984 readings went up. The department believes the data indicates that, with the completion of both projects, TSP levels will go down.

8. The department intends to shut down the Anders Residence site on December 31, 1985. Although the site meets all the "must" siting criteria, it is not a good site. It lies in a small depression below the surface of Nucleus Avenue and has several wood stove chimneys nearby. If the site was not essential for tracking the effectiveness of the control strategies, the department would move it immediately. During May, 1985, the department established a PM-10 monitoring site at the Junior High School in the northwestern part of town. The department plans to install a TSP monitor at this site in September, 1985.

Prospective Sites

The department will add Superior to its list of prospective sites. Funding is presently not available to establish a monitor at this location and, therefore, the department is merely noting interest in the area. Superior is a community of 1100 people lying along the Clark Fork River. The department suspects residential wood burning and re-entrained road dust may be causing high TSP concentrations.

WEST CENTRAL

MONTANA

West central Montana includes Missoula, Granite, Powell and Ravalli Counties. The city of Missoula is the commercial hub of the area. This region is characterized by forested mountains and narrow valleys. The region experiences poor dispersion conditions during the winter months.

Missoula

1. The city of Missoula lies within a deep mountain valley just above the confluence of the Clark Fork and Bitterroot Rivers. Over the past 15 years Missoula has experienced residential and commercial growth primarily to the southwest onto the south hill and toward the small community of Lolo. In addition, many nearby timbered canyons have experienced subdivision growth. Due to the residential growth and higher utility rates, the use of firewood for heat and enjoyment has also expanded. Winds in the Missoula Valley are light, averaging 6.1 mph. Prevailing winds are from the west or northwest. During the fall and winter, Missoula is affected by severe temperature inversions. These inversions are very persistent, lasting for days or weeks at a time.

During temperature inversions, very high concentrations of total suspended particulates have been recorded.

2. The locations of the Missoula monitoring sites are shown on Figure 23. Table 8 summarizes the TSP levels for the Missoula sites.

3. During 1984, the Missoula County Health Department operated five total suspended particulate monitoring sites within the metropolitan area of Missoula. They also performed calibrations and filter analysis for two particulate sites operated by Champion International near their Kraft pulp mill at Frenchtown.

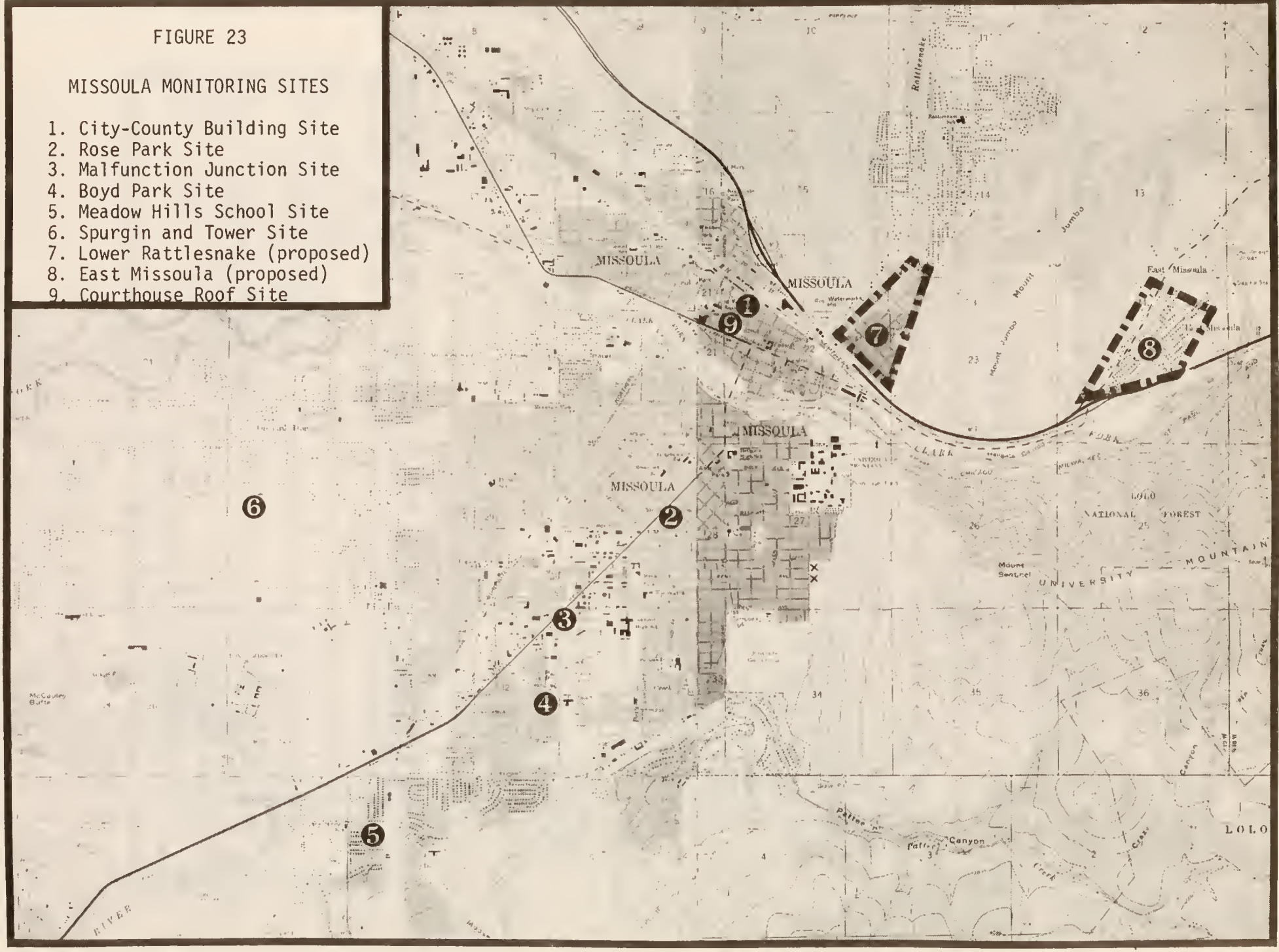
4. The Missoula County Health Department operates the Rose Park monitoring site as the primary particulate monitoring site in Missoula. The site was equipped with three high volume samplers, an additional high volume sampler with a 15 micron size selective inlet, and a GCA Beta guage (APM) to continuously measure particulates in two size categories. In October, 1984, county personnel replaced the 15 micron size selective inlet (SSI) with a PM-10 SSI. With this equipment, Missoula County gathered daily TSP data, one-in-three day PM-15 or PM-10 data, and continuous data for particles less than 2.5 microns and 2.5-15 microns. The county used the third high volume sampler during emergency episodes and whenever the Beta guage was not working. In addition, they installed a continuous Dasibi 10 micron particulate monitor and are in the process of installing another PM-10 sampler. The county intends to eventually use the Dasibi for emergency episode forecasting and thereby replace the Beta guage. The additional PM-10 monitor will allow Missoula to start daily PM-10 sampling at Rose Park.

5. Rose Park is located in a residential area near the geographical center of Missoula. However, a major arterial, Brooks Avenue, lies within one

FIGURE 23

MISSOULA MONITORING SITES

1. City-County Building Site
2. Rose Park Site
3. Malfunction Junction Site
4. Boyd Park Site
5. Meadow Hills School Site
6. Spurgin and Tower Site
7. Lower Rattlesnake (proposed)
8. East Missoula (proposed)
9. Courthouse Roof Site



block of the sampler. Several large trees near the site have grown to the point where the dripline is exactly 20 meters from the nearest high volume sampler. With this in mind, Missoula County personnel plan to eventually make Boyd Park the primary monitoring site and transfer some of the monitoring from Rose Park.

6. In 1984, the geometric mean for total suspended particulates was 54 ug/m^3. The first and second highest twenty-four hour concentrations were 294 ug/m^3 and 264 ug/m^3. The data shows compliance with the annual standards although the state and federal twenty-four hour standards were exceeded. Figure 24 is a three-year plot of monthly TSP concentrations at the Rose Park site.

7. The Montana Department of Health and Environmental Sciences performed a trend analysis on the TSP data from the Rose Park site. Figure 25 describes the results of the analysis. Although the analysis indicated that TSP levels have decreased over the past five years, the decline was not statistically significant. On the other hand, the decline over the entire seven year history of the site was statistically significant.

8. The Missoula County Health Department intends to operate the Rose Park site in its present configuration at least one more year. During the interim period, they plan to statistically compare the TSP data from Rose Park and Boyd Park. If the means are roughly equal and if the individual concentrations track each other, they plan to shift the focus for episode monitoring from Rose Park to Boyd Park. If such action is taken, Missoula County will probably reduce the amount of monitoring performed at Rose Park.

FIGURE 24

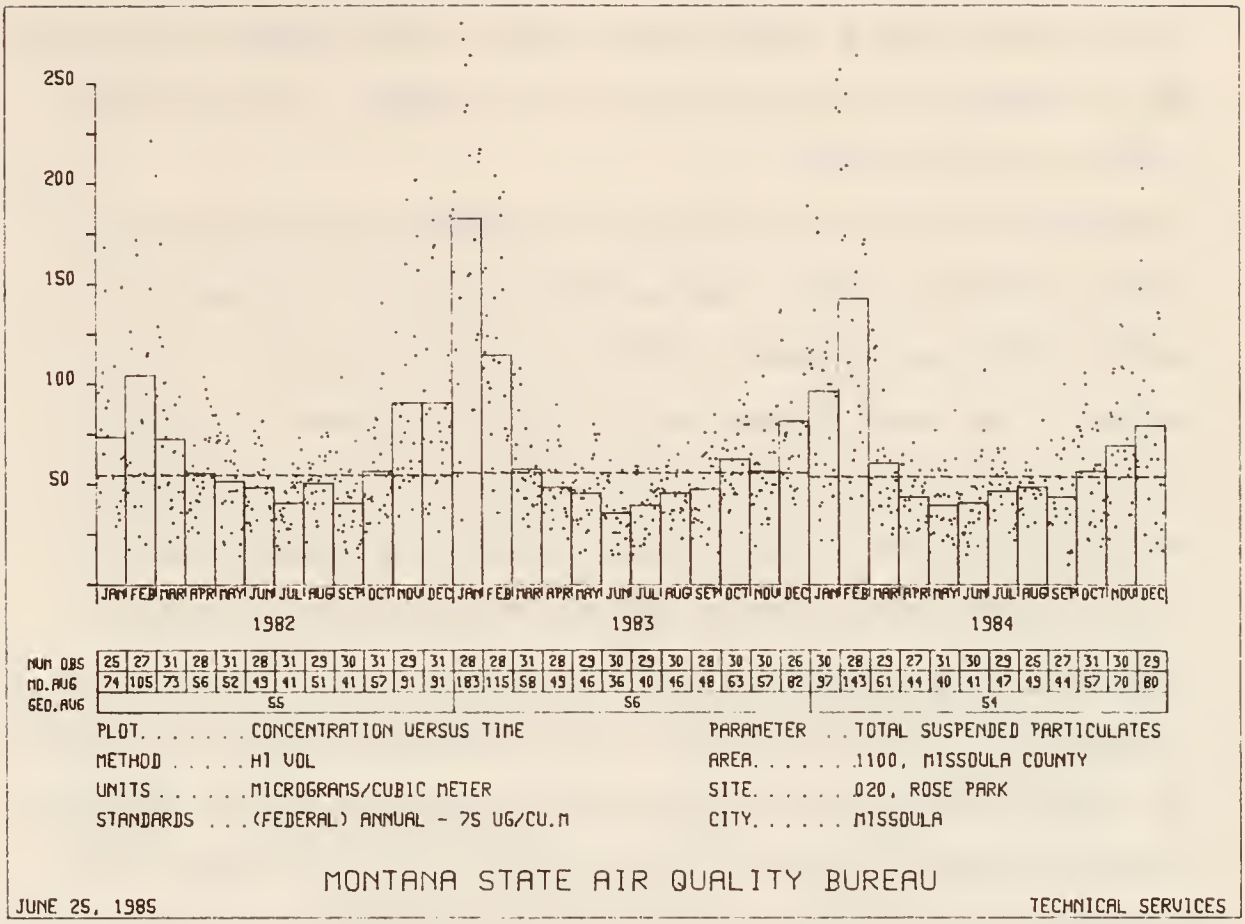
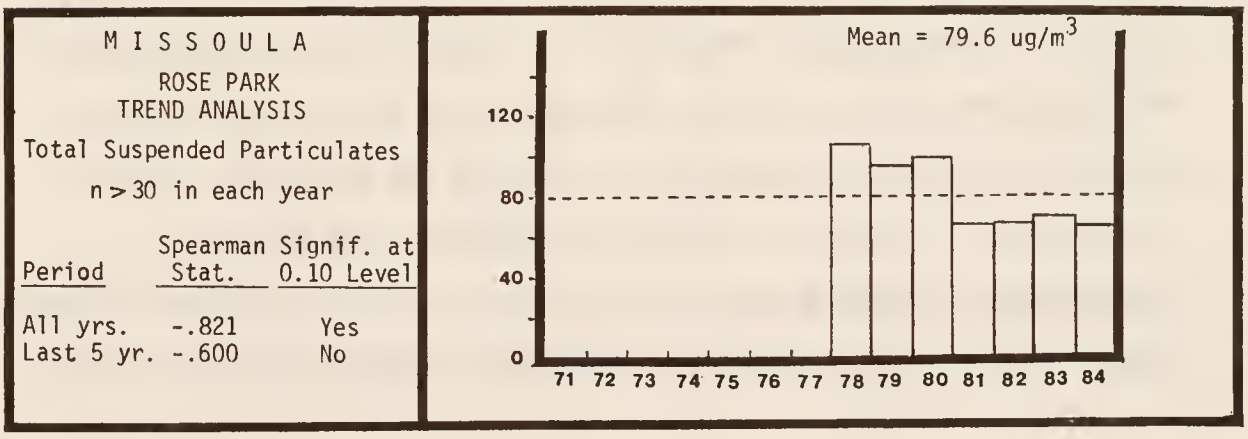

250
200
150
100
50
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1982
1983
1984
NUM OBS 25 27 31 28 31 28 31 29 30 31 29 31 28 28 31 28 29 30 29 30 28 30 30 26 30 28 29 27 31 30 29 25 27 31 30 29
NO.AUG 74 105 73 56 52 43 41 51 41 57 91 91 183 115 58 43 46 36 40 46 48 63 57 82 97 143 61 44 40 41 47 49 44 57 70 80
GEO.AUG 55 56 54
PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M
PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 1100, MISSOULA COUNTY
SITE. . . . . 020, ROSE PARK
CITY. . . . . MISSOULA
MONTANA STATE AIR QUALITY BUREAU
JUNE 25, 1985
TECHNICAL SERVICES

FIGURE 25



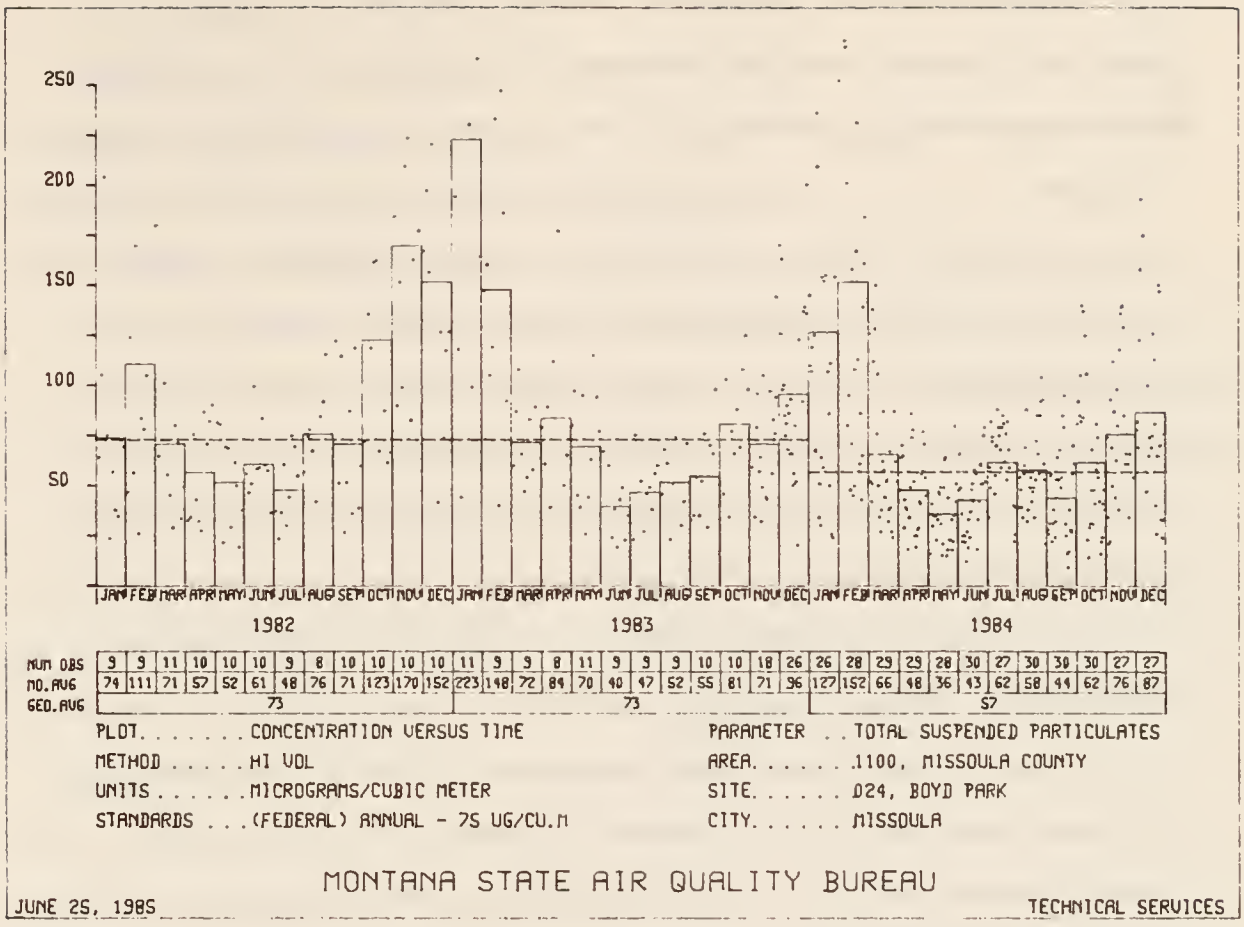
9. The Boyd Park monitoring site is located in a residential area on the south side of the city just below the South Hill. Homeowners in this part of Missoula use a large amount of wood for home heating. The actual site is located in a grassy area well off the street. The site easily meets all siting criteria.

10. During 1984, the Missoula County Health Department operated three high volume samplers and a PM-15 size selective inlet (SSI) at Boyd Park. In October, 1984, they replaced the PM-15 SSI with a PM-10 SSI. With this equipment, the county gathered daily TSP data, collocated TSP data, and one-in-three day PM-15 or PM-10 data. Missoula County has installed a continuous Dasibi PM-10 monitor and will soon add a second PM-10 SSI. The county moved the collocated TSP sampler to the Health Department roof site in January, 1985.

11. During 1984, the geometric mean for TSP at Boyd Park was 56 ug/m^3. The two highest twenty-four hour concentrations were 440 ug/m^3 and 408 ug/m^3. These high readings occurred during the last two days of January. The TSP data from Boyd Park continued to exceed the Montana and federal twenty-four hour ambient standards during 1984. However, the annual standards were not exceeded. Figure 26 is a three year plot of monthly TSP concentrations at the Boyd Park site.

12. The Missoula County Health Department will continue to operate the Boyd Park site indefinitely. During 1985 they intend to gather daily TSP data, daily PM-10 data and continuous data for the less than 10 micron size classes. As mentioned earlier, the Missoula County Health Department may designate the Boyd Park site as the focus of their episode monitoring program. They believe that the site easily meets all siting

FIGURE 26


250
200
150
100
50
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1982
1983
1984
NUM OBS 9 9 11 10 10 10 9 8 10 10 10 10 11 9 9 8 11 9 9 9 10 10 18 26 26 28 29 29 28 30 27 30 30 30 27 27
NO.AVG 74 111 71 57 52 61 48 76 71 123 170 152 223 148 72 84 70 40 47 52 55 81 71 96 127 152 66 48 36 43 62 58 44 62 76 87
GEO.AVG 73 73 57
PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M
PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 1100, MISSOULA COUNTY
SITE. . . . . 024, BOYD PARK
CITY. . . . . MISSOULA
MONTANA STATE AIR QUALITY BUREAU
JUNE 25, 1985
TECHNICAL SERVICES

criteria and would therefore be representative of a greater geographical area.

13. The Missoula County Courthouse is located in a commercial district along Broadway Street. The county operated the Courthouse Roof site continuously from 1971 until December, 1984, when they moved the site to the new City-County Building on Alder Street.

14. The Courthouse roof site registered a 1984 geometric mean equal to the federal annual secondary standard of 60 ug/m^3. The two highest indivi-

dual readings were 301 ug/m^3 and 270 ug/m^3. These values exceeded both the state and federal twenty-four hour standards.

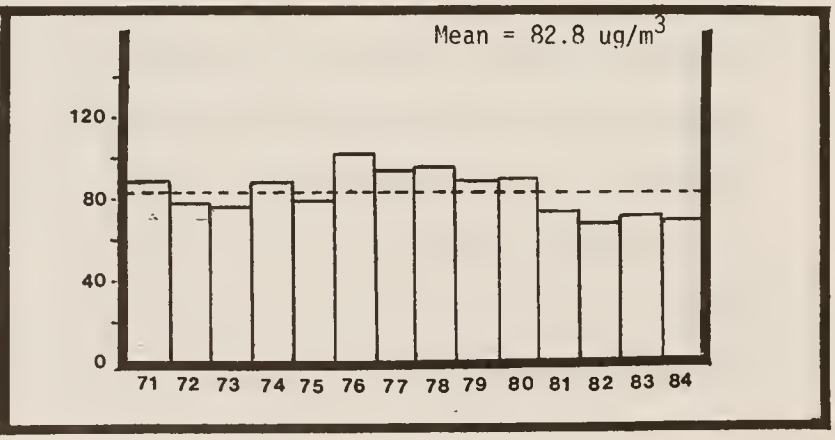
15. DHES conducted a trend analysis of the data from the Courthouse Roof site. The analysis addressed the past five years as well as the entire fourteen year history of the site. The results are graphically displayed in Figure 27. The total suspended particulate concentrations decreased over both time periods but neither decline was statistically significant.

16. As mentioned earlier, Missoula moved the Courthouse Roof site to the City-County Building during December, 1984. The new location is in the same part of town (two blocks north of the Courthouse) and is more convenient to operate since the Missoula County Health Department offices are in the building. In addition, the roof of the City-County Building is lower than the Courthouse roof and therefore it complies more closely with vertical placement requirements. The new location lies on the boundary between a commercial-light industrial area and a residential area. The City-County Building is the new collocated TSP site in Missoula. The County intends to install a PM-10 monitor at this site if an arrangement can be made with EPA to exchange a PM-15 sampling head for a PM-10 inlet.

FIGURE 27

MISSOULA
COURTHOUSE ROOF
TREND ANALYSIS
Total Suspended Particulates
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.393	No
Last 5 yr.	-.700	No



17. The Missoula County Health Department has operated a site at the Meadow Hills School in southwest Missoula for almost two years. The site is in a residential area and easily meets all siting criteria. In October, 1984, Missoula County removed the high volume sampler and replaced it with a 15 micron size selective inlet.

18. In 1984, the geometric mean for TSP was 37 ug/m^3. This value is considerably lower than the Boyd Park site which is located 1.5 miles northeast. The highest twenty-four hour reading was also lower than most other Missoula sites at 194 ug/m^3. During 1984, the data from the Meadow Hills site met all ambient standards.

19. The Missoula County Health Department will continue to operate this site for at least one more year. The sampler will be equipped with a 15 micron size selective inlet unless personnel from EPA Region VIII can exchange the 15 micron inlet for a 10 micron inlet.

20. The Spurgin and Tower site is located just south of the Orchard Homes district in the western half of Missoula. The site is on undeveloped land which is part of the Montana Division of Forestry's nursery. There are virtually no emission sources within a quarter of a mile of this site.

21. Missoula County personnel have operated this site for almost two years. In 1984, the geometric mean was very low at 33 ug/m^3. The highest twenty-four hour reading was 147 ug/m^3. In light of the low readings, Missoula County will shut down the Spurgin and Tower site during the summer of 1985 and install a new site in either East Missoula or the lower Rattlesnake, provided an acceptable site can be found.

22. East Missoula is separated from Missoula by a constriction in the Clark Fork Valley known as Hellgate Canyon. Missoula County would like to determine what the TSP levels are in this area.

23. The lower Rattlesnake is situated near the point where the Rattlesnake Canyon opens into the Missoula Valley. County personnel suspect that wood smoke emissions from the residential areas extending up the canyon drift downslope until particulate levels hit a maximum in this area.

Hamilton

1. Hamilton is a community of 2600 people lying in the center of the Bitterroot Valley approximately 50 miles south of Missoula. The elevation of Hamilton is 3550 feet or about 300 feet higher than Missoula. Hamilton often experiences much better wintertime ventilation than nearby Missoula. On many occasions, when Missoula is fogged in and experiencing high TSP concentrations, Hamilton is sunny and relatively clear. The department speculates that the downslope drainage winds cause the nighttime cold air to move through Hamilton and pool near Missoula. This cold air is associated with fog which prevents the sun from reaching the ground and heating up the surface layer of air. However, Hamilton is generally above the cold air layer.

2. The department has operated a high volume sampler on the roof of the Ravalli County Courthouse since January, 1984. The general location of the site is shown in Figure 28. The TSP data is summarized in Table 8.

3. During 1984, the geometric mean for TSP was 49 ug/m^3. This concentration is quite low for a western Montana community. There were only four twenty-four hour readings over 100 ug/m^3 and three of the four occurred

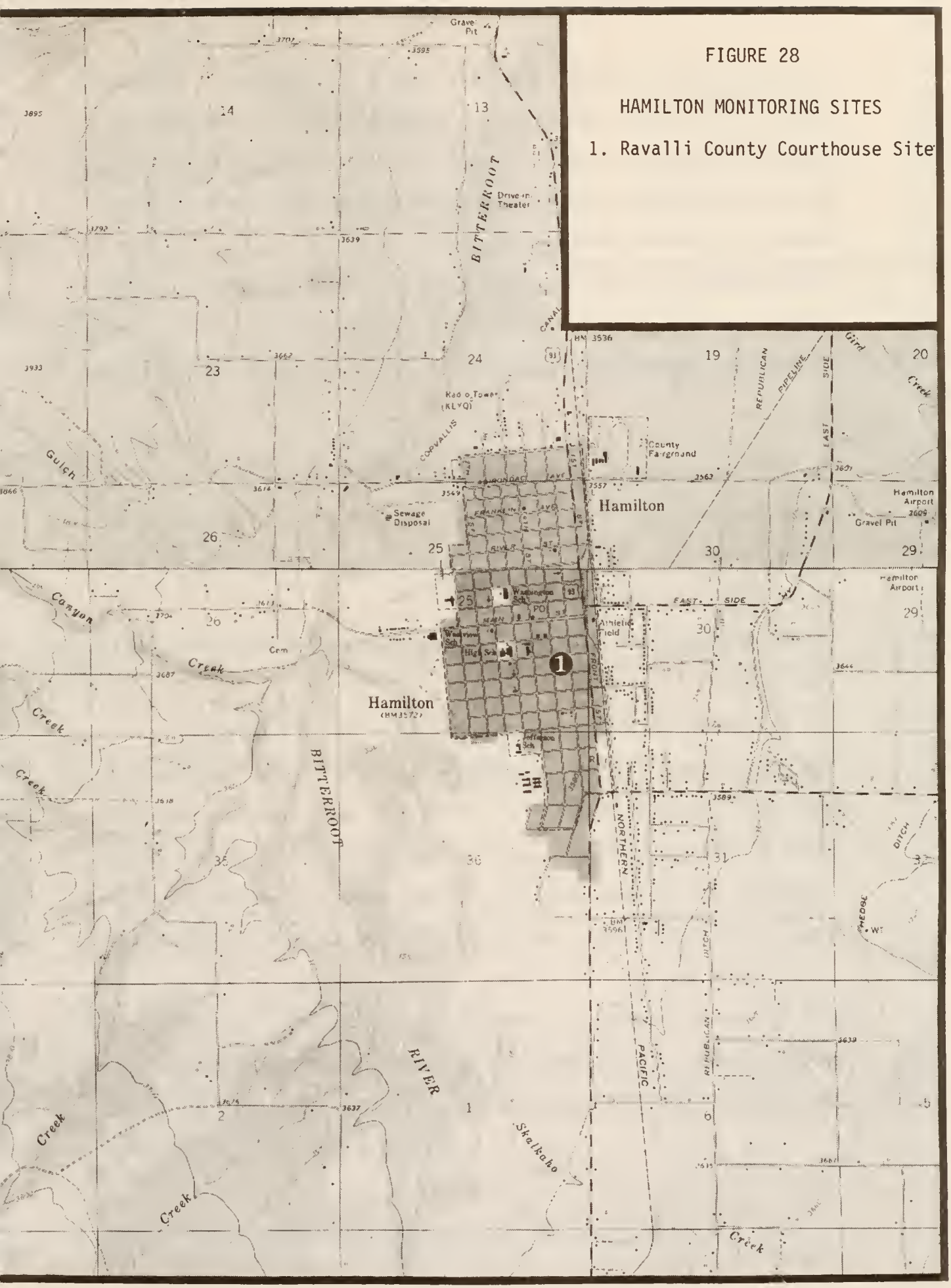


FIGURE 28

HAMILTON MONITORING SITES

1. Ravalli County Courthouse Site

during the winter months of December, January and February. The seasonal nature of the higher readings points toward residential wood smoke as a significant emission source. The data from the Ravalli County Courthouse site shows compliance with Montana and federal primary standards but exceeds the federal secondary standards.

4. The first year of total suspended particulate data showed concentrations high enough to warrant continued particulate monitoring. In comparison to other western Montana communities; however, the levels are quite low.

Ovando

1. The department operates a western Montana background sampler at the Smith Ranch near Ovando. The Smith Ranch is in the sparsely populated upper Blackfoot Valley. The entire area is used almost exclusively for hay production and livestock grazing.
2. Figure 29 shows the location of the site and Table 8 summarizes the associated data.
3. The 1984 geometric mean of 15 ug/m^3 is very low and typical of a background site. The geometric mean was almost identical to data from past years even though some high twenty-four hour concentrations (231 ug/m^3 and 145 ug/m^3) occurred during August, 1984. The department is convinced that fugitive dust from sorting sheep in an adjacent pen is responsible for the high readings, although smoke from numerous August forest fires may have contributed.
4. The department intends to operate the Ovando site as a background monitor indefinitely. In July, 1985, the department installed a PM-10 monitor at the Ovando site to determine background levels of fine particulates.

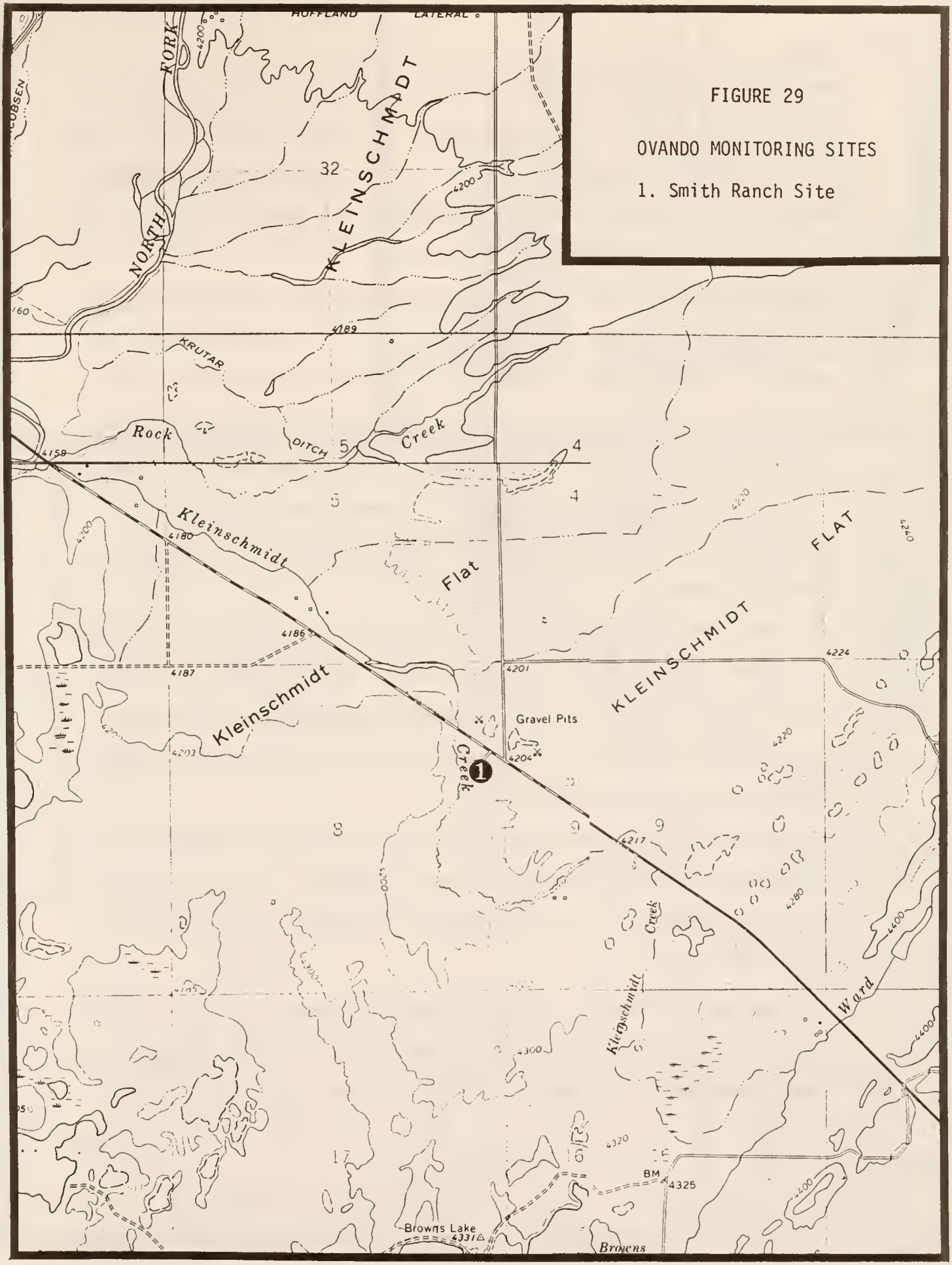


FIGURE 29

OVANDO MONITORING SITES

1. Smith Ranch Site

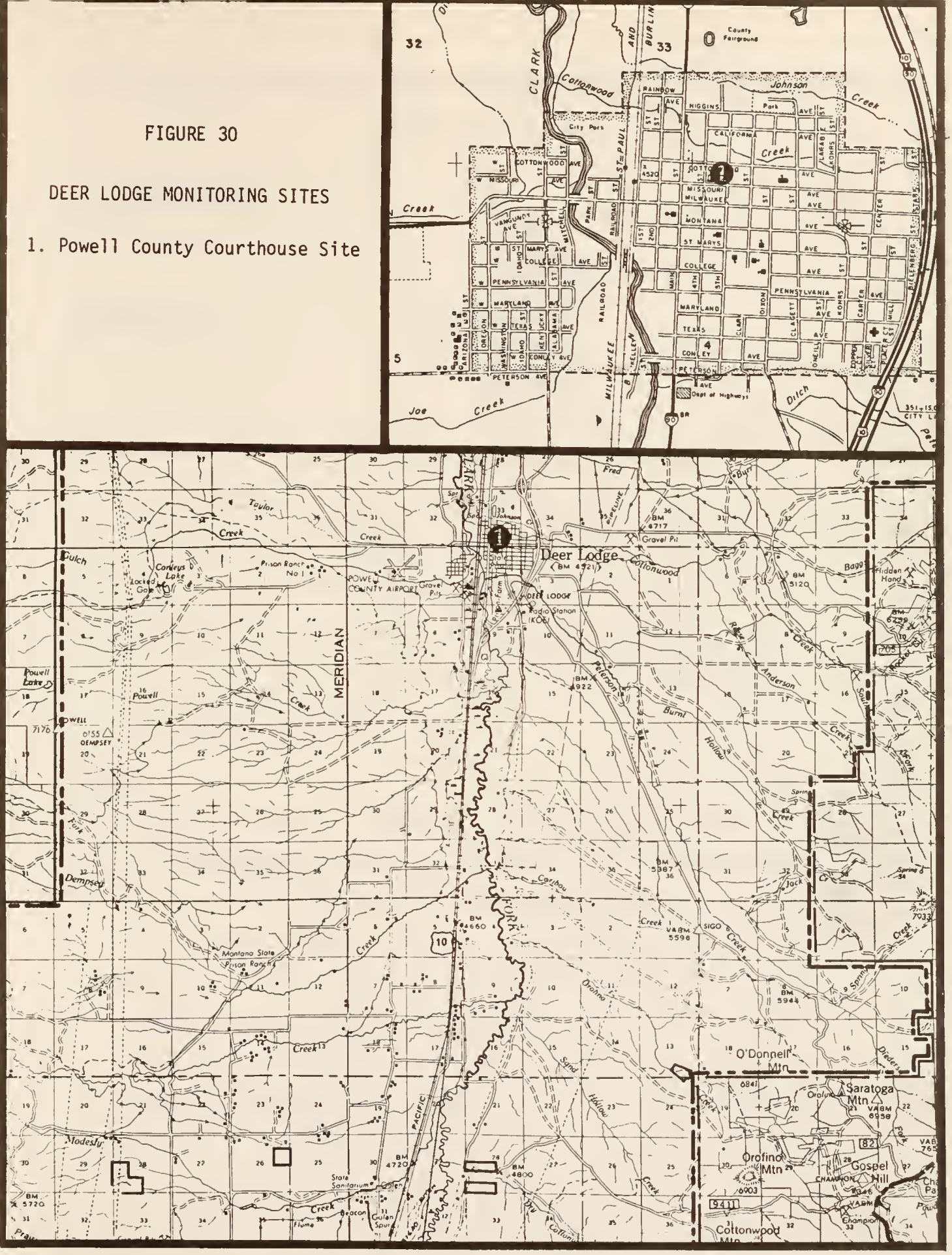
Deer Lodge

1. Deer Lodge is a small town of 4000 people located near the north end of the Deer Lodge Valley. The valley slopes from almost 5300 feet above sea level in the south to 4400 feet in the north. The valley is surrounded by mountains with the 10,000 foot high Flint Creek Range to the west and the 7000 foot Continental Divide to the east.
2. The department began TSP sampling at the Powell County Courthouse in Deer Lodge during July, 1984. The establishment of a site in Deer Lodge was consistent with the 1983 and 1984 Network Reviews which proposed short-term sampling in all western Montana communities with populations over 1000 people. The purpose of the sampling is to determine total suspended particulate concentrations in previously unmonitored communities.
3. Figure 30 shows the monitoring site location and Table 8 summarizes the associated data.
4. The Deer Lodge County Courthouse is located in a residential part of town one and one-half blocks off the main street. The immediate area around the Courthouse is comprised of older homes and associated larger trees. The high volume sampler is located on the roof of the Courthouse approximately 40 feet above ground level.
5. The geometric mean for the last six months of 1984 was 43 ug/m^3 and the highest twenty-four hour concentration was 109 ug/m^3. Both these concentrations are very low and in compliance with all Montana and federal ambient standards.
6. The department intends to operate this site at least until the end of 1985. The department will review the data during the development of the 1986 Network Review and decide the future of the site at that time.

FIGURE 30

DEER LODGE MONITORING SITES

1. Powell County Courthouse Site



SOUTHWEST

MONTANA

Southwest Montana includes Beaverhead, Broadwater, Deer Lodge, Jefferson, Gallatin, Lewis and Clark, Madison, Meagher, and Silver Bow Counties. This region of Montana has very high mountains; however, the valleys are considerably wider than the valleys of northwest and west central Montana. Winter dispersion conditions are better than the more western regions, but severe temperature inversions do occur.

Helena

1. The city of Helena is situated near the south end of the Helena valley. The elevation of the city varies from 3850 feet in the north part of Helena to over 4200 feet at the extreme southern edge of the city. The Helena valley is meteorologically similar to other western Montana valleys. Prevailing winds are generally light (average - 7.5 mph) and from the southwest, west or northwest directions.
2. Figure 31 shows the location of the Helena sites on a city map while Table 8 summarizes the particulate data.

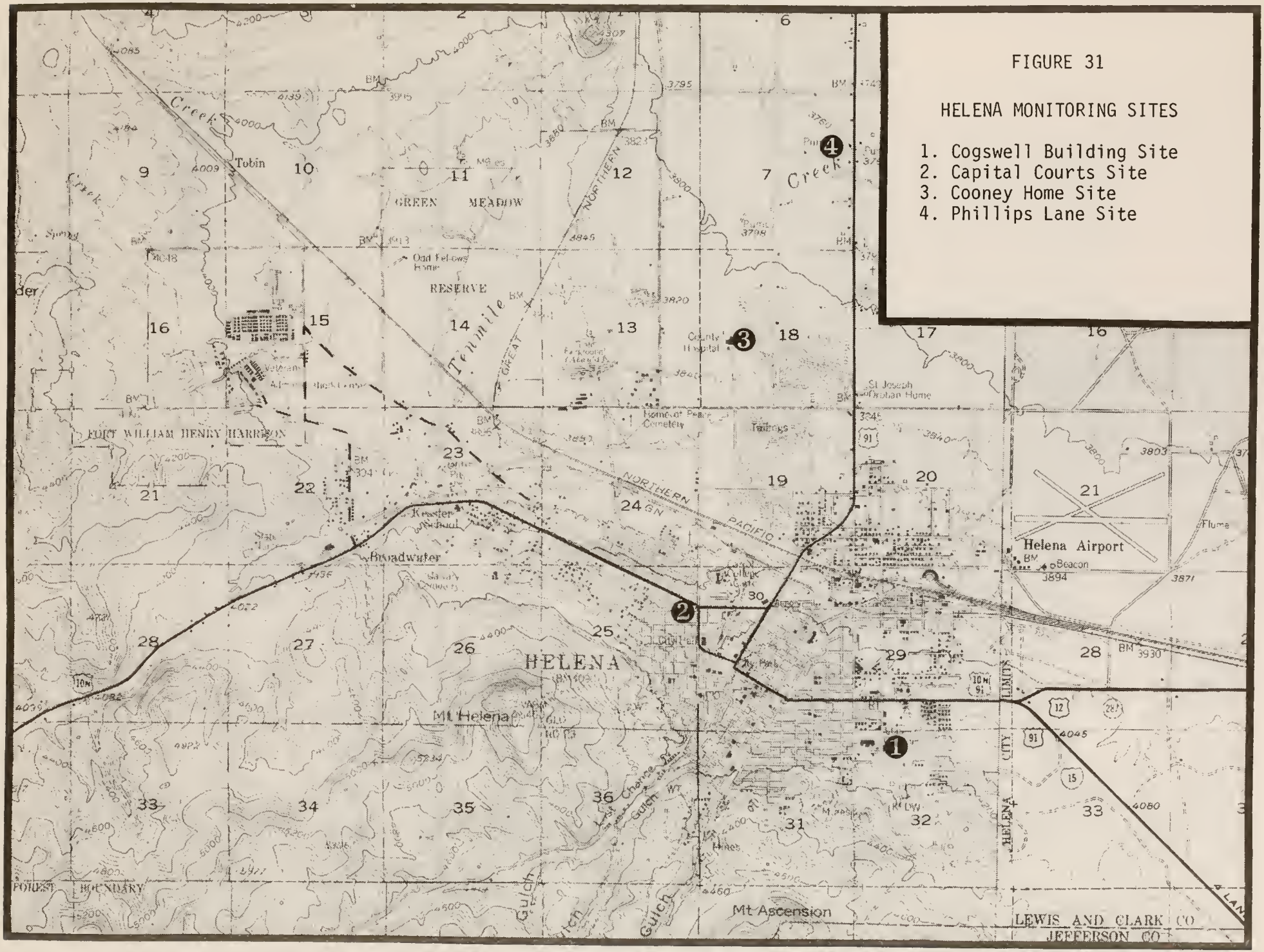


FIGURE 31
HELENA MONITORING SITES
1. Cogswell Building Site
2. Capital Courts Site
3. Cooney Home Site
4. Phillips Lane Site
HELENA
Mt Helena
Mt Ascension
Helena Airport
Broadwater
FORT WILLIAM HENRY HARRISON
GREEN MEADOW
RESERVE
Tobin
Tenmile Creek
NORTHERN PACIFIC
GREAT NORTHERN
LEWIS AND CLARK CO
JEFFERSON CO

3. The Cogswell Building site has been the mainstay of the Helena particulate sampling network for almost ten years. The Cogswell Building is part of the Capitol Complex which lies on the south side of Helena at an elevation of 4120 feet. The area surrounding the Capitol Complex is generally residential with older homes to the west and newer homes to the east. The Prospect and 11th Avenue strip development is located four blocks to the north.

4. In 1984, the geometric mean at the Cogswell Building for total suspended particulates was quite low at 42 ug/m^3. The first and second highest twenty-four hour values were 248 ug/m^3 and 120 ug/m^3. These concentrations are in compliance with all state and federal ambient standards.

5. The department performed a trend analysis on the particulate data from the Cogswell Building and the results are provided in Figure 32. The department performed the analysis for the entire nine year history of the site and the most current five years. The results for both time periods showed decreasing concentrations but neither was statistically significant. Despite the overall decline, the 1984 geometric mean for TSP was five percent higher than in 1983.

6. Due to the long historical record at this site and its convenient location, the department recommends that sampling continue at the Cogswell Building. The department also has installed and is operating collocated PM-10 monitors at this site.

7. The Capital Courts site is operated by the Lewis and Clark County Health Department. The high volume sampler is located on the roof of the Capital Courts Athletic Club which is on the north edge of a residential area and one block south of a commercial strip.

FIGURE 32

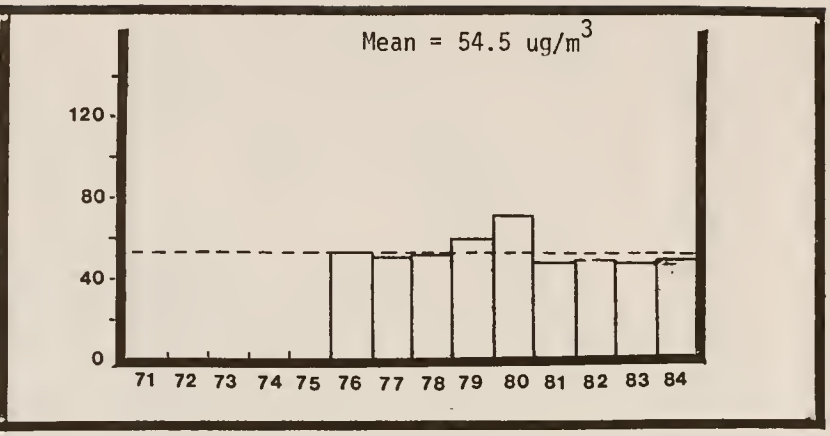
HELENA

COGSWELL BUILDING
TREND ANALYSIS

Total Suspended Particulates

n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.567	No
Last 5 yr.	-.300	No



8. During 1984, the Capital Courts site registered a geometric mean for TSP of 46 ug/m^3. Although this was the highest geometric mean recorded in Helena during 1984, it is still quite low. TSP data from the Capital Courts site met all state and federal ambient standards.

9. The department conducted an analysis of TSP trends at the Capital Courts site. Figure 33 graphically displays the results of the analysis. Over the five year history of the site, TSP levels have decreased but the decline is not statistically significant.

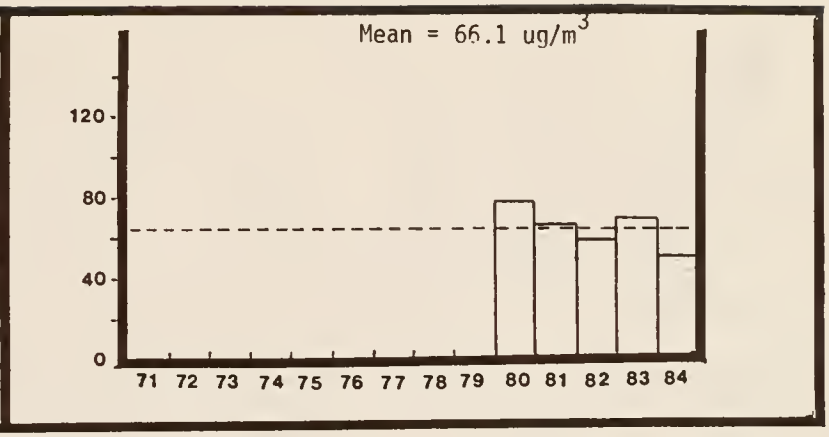
10. The Lewis and Clark County Health Department intends to continue to operate this site.

11. The Lewis and Clark County Health Department also operates a high volume sampler at the Cooney Rest Home near the north edge of town. The site is at an elevation of 3820 feet which is about the lowest point within the city limits of Helena. The sampler will be moved to a new location in

FIGURE 33

HELENA
CAPITAL COURTS
TREND ANALYSIS
Total Suspended Particulates
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.700	No



the Helena valley because the abandoned Cooney Home is scheduled for demolition.

12. The Cooney Home site recorded surprisingly low TSP concentrations during 1984. The geometric mean and maximum twenty-four hour readings of 33 ug/m^3 and 98 ug/m^3, respectively, were both the lowest values recorded in Helena. Although the maximum twenty-four hour concentration was down in 1984, the geometric mean was identical to 1983.
13. The Lewis and Clark County Health Department will operate a new site in the valley for at least one year.

East Helena

1. East Helena is a small community about five miles east of Helena and is the site of the ASARCO lead smelter and the American Chemet paint pigment plant. East Helena is experiencing rapid residential growth along its northern and eastern edges.

2. During 1984, the department, in cooperation with the ASARCO lead smelter, operated five TSP sites in the vicinity of East Helena. The Dartman Field and South sites were operated exclusively by the department; however, the Hastie, Firehall, and Hadfield sites were a joint effort. ASARCO provided day to day operation of the three sites while the department provided most of the equipment, calibrations, filters and filter analyses. The sampling frequency was once every sixth day for the South and Dartman Field sites and once every third day for the other three. Although total suspended particulates are monitored, the primary objective of all five sites is to track lead concentrations around the ASARCO smelter and the American Chemet plant.

3. The locations of the East Helena sites are shown in Figure 34. Table 8 summarizes the associated TSP data.

4. The Hastie site is situated on Pacific Street in East Helena just across U.S. Highway 12 from the American Chemet plant and the ASARCO smelter. The Hastie site has operated for over ten years and TSP data from the site was responsible for designating the area nonattainment for primary and secondary TSP standards.

5. In 1984, TSP levels at the Hastie site were in compliance with all state and federal ambient standards. The annual geometric mean was down two percent from 1983 and stood at 52 ug/m^3. The highest twenty-four hour concentration was 141 ug/m^3.

6. The department conducted a trend analysis on the TSP data gathered at the Hastie site. Figure 35 displays the results of the analysis. The department performed the analysis for two time periods: the last five years and the entire ten year history of the site. The results indicated decreasing TSP levels for both periods but only during the last five

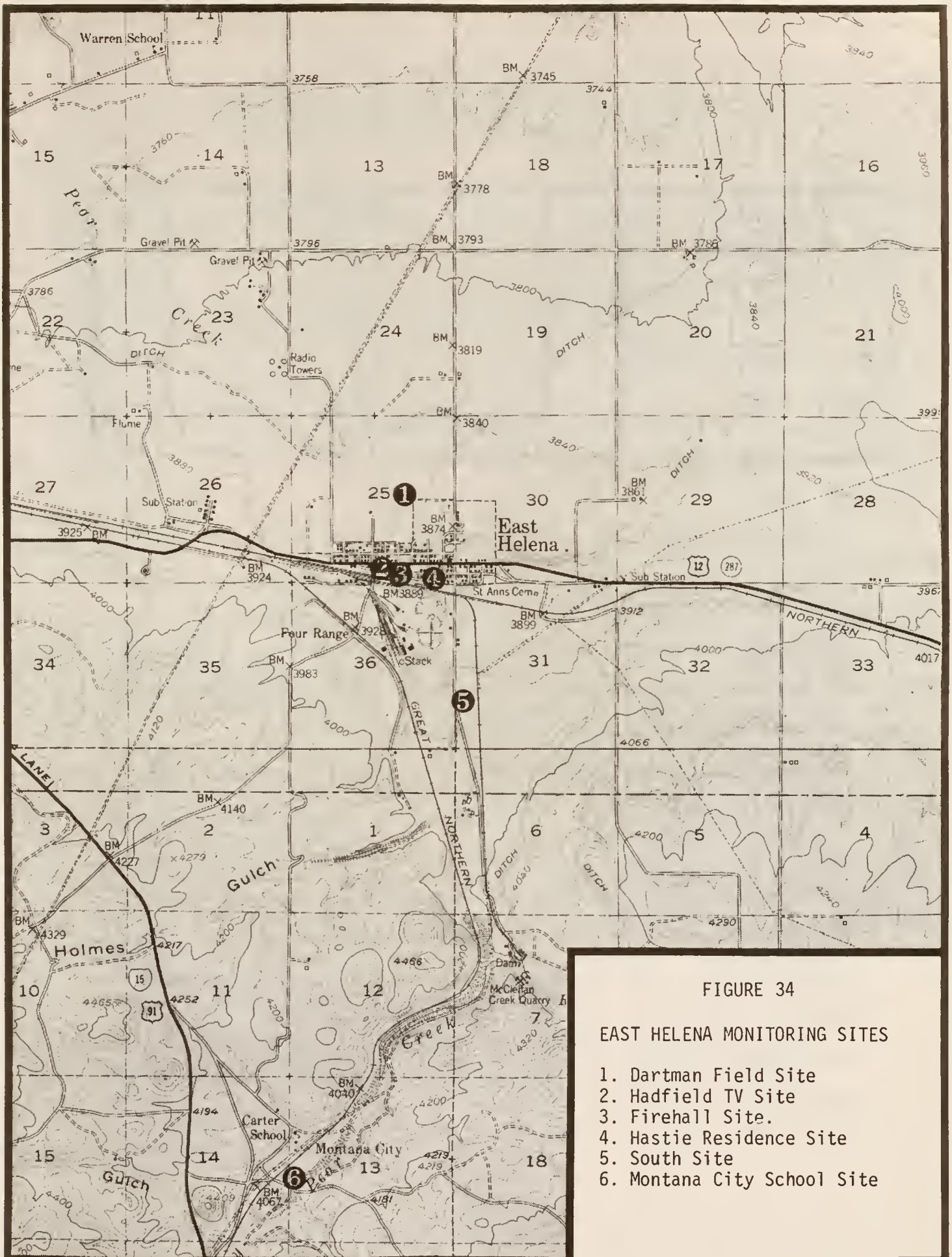


FIGURE 34

EAST HELENA MONITORING SITES

1. Dartman Field Site
2. Hadfield TV Site
3. Firehall Site.
4. Hastie Residence Site
5. South Site
6. Montana City School Site

FIGURE 35

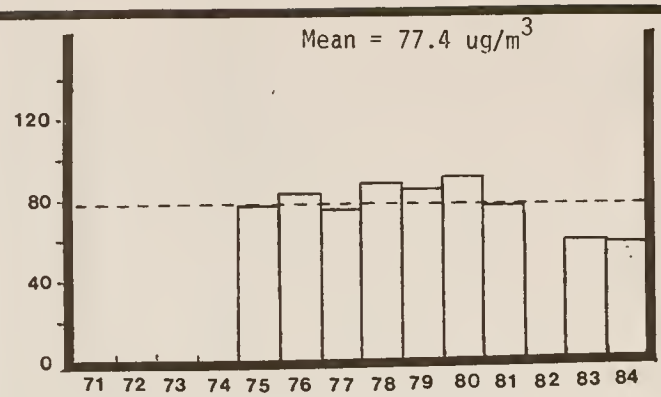
EAST HELENA

HASTIE RESIDENCE
TREND ANALYSIS

Total Suspended Particulates

n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.418	No
Last 5 yr.	-.900	Yes



years was the trend statistically significant. Although TSP concentrations may actually be decreasing in East Helena, the decrease at the Hastie site may also have been caused by the fact that nearby trees are overgrowing the site and may be serving as a filter.

7. The department compared TSP data between each East Helena site using linear regression analyses. The results for the Hastie site are listed in Table 14. TSP levels at the Hastie site correlated very well with levels from the Firehall, South and Dartman Field sites. Only a fair correlation was observed with data from the Hadfield site. These results are inconsistent with similar analyses contained in the 1983 Network Review. In the earlier analyses, the data from the South site show a poor correlation with the Hastie site while the Hadfield site correlated well.

TABLE 14

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS
BETWEEN THE HASTIE SITE AND OTHER EAST HELENA SITES

	Firehall	South	Hadfield	Dartman Field
TSP	0.837	0.845	0.688	0.830
Arsenic	0.629	-0.001	0.477	0.571
Cadmium	0.667	0.085	0.325	0.694
Copper	0.706	0.779	0.746	0.875
Lead	0.686	0.001	0.459	0.671
Zinc	0.797	-0.104	0.222	0.214

8. During 1984, the department analyzed the East Helena high volume sampler filters for arsenic, cadmium, copper, lead and zinc. Table 15 provides the annual arithmetic mean for TSP and metal concentrations at each East Helena monitoring site. This table also indicates the percentage of TSP that each metal represents. At the Hastie site, almost twelve percent of the annual TSP catch is heavy metals. In light of the toxicity of some of these elements, the department considers East Helena a high priority area. It also emphasizes that industrial emissions from the ASARCO smelter and the American Chemet plant are important contributors to TSP. However, the department is uncertain if direct industrial emissions or re-entrained historical emissions are more important. The department compared TSP data and its elemental constituents at each East Helena site by linear regression. The results for the Hastie site are given in Table 16. Of the five elements considered, lead exhibited the best correlation with TSP. However, all five elements displayed positive and

significant correlations. This fact reinforces the need to consider the sources of trace metals as significant contributors to TSP.

TABLE 15

ELEMENTAL COMPOSITION OF EAST HELENA TSP

	Hastie	Firehall	South	Hadfield	Dartman Field
TSP	57	75	41	86	50
As	.195 (0.3%)	.416 (0.6%)	.097 (0.2%)	.261 (0.3%)	.206 (0.4%)
Cd	.117 (0.2%)	.250 (0.3%)	.065 (0.2%)	.193 (0.2%)	.137 (0.3%)
Cu	1.64 (2.9%)	7.25 (9.7%)	0.41 (1.0%)	3.90 (4.5%)	1.91 (3.8%)
Pb	2.88 (5.1%)	5.28 (7.0%)	1.27 (3.1%)	3.48 (4.0%)	2.69 (5.4%)
Zn	1.94 (3.5%)	3.02 (4.0%)	0.45 (1.1%)	8.41 (9.8%)	1.78 (3.6%)
Total Metals	6.80 (11.9%)	16.21 (21.6%)	2.29 (5.6%)	16.24 (18.8%)	6.72 (13.4%)

TABLE 16

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS AT THE EAST HELENA HASTIE SITE

	TSP	Arsenic	Cadmium	Copper	Lead	Zinc
TSP	---	0.455	0.251	0.340	0.527	0.105
Arsenic	0.455	---	0.587	0.057	0.879	0.346
Cadmium	0.251	0.587	---	0.014	0.642	0.274
Copper	0.340	0.057	0.014	---	0.149	0.049
Lead	0.527	0.879	0.642	0.149	---	0.443

9. The department compared trace metals with each other at the Hastie site and the results are shown in Table 16. Lead and arsenic correlated very well while cadmium and lead displayed a fair correlation. All other elemental comparisons indicated either poor or no correlations. The worst correlation was between cadmium and copper. The department suspects that the very good correlation between lead and arsenic indicates they are coming from the same emission source. Of course, the opposite conclusion would apply to cadmium and copper.

10. The department also compared the Hastie site trace metal data with similar data from the other East Helena sites. The results are summarized in Table 14.

    The department noted two interesting relationships in the results of this analysis: (1) the copper data from the Hastie site correlated well or very well with all other sites and (2) all other trace metals except copper show little or no correlation with similar data at the South site. Taking an overall perspective of the trace metal data, the department found that the Hastie site data correlated well with the Firehall and Dartman Field data, fairly well with the Hadfield data and very poorly with the South site data. The department believes the results indicate that the Hastie site is impacted by similar sources to those impacting the Firehall and Dartman Field sites. On the other hand, the South site appears to be influenced by a substantially different set of sources. The department was surprised at how well copper correlated on a network-wide basis. It appears that an areawide copper source must exist, otherwise variations in wind directions would result in a poor correlation between copper at the Hastie and South sites. The department suspects that re-entrained fugitive dust contaminated with copper is the source.

However, these dust sources would also be contaminated with the other metals, which do not correlate between the Hastie and South sites. Therefore, the cause of the network-wide correlation for copper remains unknown.

11. The department intends to terminate monitoring at the Hastie site. The primary reason for shutting down the site is to save over $4,000.00 annually in laboratory charges. The department identified several other supporting reasons:
    a. Of the three sites in this part of East Helena, the Hastie site recorded the lowest TSP and lead concentrations during 1983 and 1984.
    b. The TSP and metals data from the Hastie site tracked similar data from the Firehall site, indicating that the Firehall site can adequately monitor this area of town.
    c. The Hastie site is slowly being overgrown by nearby trees.
12. The Hadfield site is located just south of the main street of East Helena. The department and ASARCO cooperatively operate collocated high volume samplers at this site.
13. In 1984, TSP concentrations at the Hadfield site exceeded the state and federal primary twenty-four hour standards. The highest twenty-four hour concentration was 326 ug/m^3. The Montana annual standard and the federal secondary annual standard were also exceeded. The annual geometric mean was 70 ug/m^3 and the arithmetic mean was 86 ug/m^3.
14. The department used linear regression analyses to compare the TSP data from the Hadfield site with similar data from the other East Helena sites. The results are shown in Table 17. TSP data from the Hadfield site correlated very well with data from the Dartman Field site. Similarly, a good correlation was observed with data from the Firehall

TABLE 17

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS
BETWEEN THE HADFIELD SITE AND OTHER EAST HELENA SITES

	Hastie	Firehall	South	Dartman Field
TSP	0.688	0.729	0.761	0.831
Arsenic	0.477	0.806	0.203	0.858
Cadmium	0.325	0.751	0.201	0.677
Copper	0.746	0.813	0.863	0.973
Lead	0.459	0.787	0.072	0.794
Zinc	0.222	0.507	0.080	0.834

and South sites. On the other hand, only a fair correlation existed with data from the Hastie site.

15. The department summarized the trace metal data for the Hadfield site in Table 15. The data indicates that almost 19 percent of the total suspended particulates are trace metals. Zinc made up 9.8 percent of the total suspended particulates while both copper and lead comprised over 4 percent. The department considers these high trace metal concentrations to be indicators of the impacts of the American Chemet plant and the ASARCO lead smelter. The zinc concentrations at the Hadfield site are actually more than twice as high as the next highest site. Since the American Chemet plant is a major zinc oxide emitter, it most likely is a signficant contributor to TSP at the Hadfield site. On the other hand, the Firehall site is closer to the American Chemet plant than the Hadfield site and zinc concentrations are considerably lower there.

16. The department performed linear regression analyses to compare the Hadfield TSP data with each of its trace metal constituents. Table 18

TABLE 18

CORRELATION COEFFICIENTS FOR TSP AND
TRACE METALS AT THE EAST HELENA HADFIELD SITE

	TSP	Arsenic	Cadmium	Copper	Lead	Zinc
TSP	---	0.599	0.492	0.376	0.556	0.702
Arsenic	0.599	---	0.531	0.237	0.854	0.328
Cadmium	0.492	0.531	---	0.114	0.555	0.358
Copper	0.376	0.237	0.114	---	0.286	0.038
Lead	0.556	0.854	0.555	0.286	---	0.251
Zinc	0.702	0.328	0.358	0.038	0.251	---

shows the results of the analysis. The zinc data correlated well with TSP. The other four trace metals displayed poor correlations with TSP, although they were positive correlations. The department believes that the positive correlations underscore the influence that sources emitting trace metals, and especially zinc, have on TSP.

17. The department also compared each of the Hadfield trace metals with each other (see Table 18). Similar to the results from the Hastie site, the best correlation was observed between lead and arsenic. Although all the correlation coefficients were positive, the correlation between cadmium and copper and copper and zinc were very poor.

18. In addition, the department compared the Hadfield trace metal data with trace metal data from the other sites (see Table 17). Just like the data from the Hastie site, copper showed a good to excellent correlation between all sites. In fact, the correlation coefficient for copper between the Hadfield and Dartman Field sites was 0.973. Copper was the only trace metal which showed even a fair correlation with similar data from the South site. This relationship was also noted at the Hastie

site. In general, the trace metal data from the Hadfield site correlated very well with the Dartman Field site, well with the Firehall site, fairly well with the Hastie site, and poorly with the South site. It appears that similar sources are impacting the Hadfield, Hastie and Firehall sites.

19. The department intends to operate the Hadfield site indefinitely. The Hadfield site recorded the highest TSP concentrations in East Helena and is essential for tracking the TSP control plan. It is also a key site for assessing the effectiveness of the East Helena lead control strategies.

20. The Firehall site is located on Pacific Street across Highway 12 from the ASARCO smelter and the American Chemet plant. The site is approximately 1.5 blocks southeast of the Hadfield site. The high volume sampler is on the roof of the Firehall about 20 feet above ground level. The Firehall site was the key site in designing the lead control strategies for East Helena.

21. In 1984, TSP levels at the Firehall site equaled the state's annual standard and exceeded the twenty-four hour standard. The federal secondary standards were also exceeded, although the primary standards were met. The 1984 geometric mean increased slightly to 66 ug/m^3. The highest individual reading was 216 ug/m^3.

22. The department performed linear regression analyses to compare TSP data between East Helena sites. Table 19 summarizes the results. TSP data at the Firehall site correlated very well with TSP data from the Dartman Field and Hastie sites and well with data from the South and Hadfield sites. The good correlation with the data from the South site is surprising since the two sites are located in opposite directions from the smelter complex and at least one mile apart.

TABLE 19

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS
BETWEEN THE FIREHALL SITE AND OTHER EAST HELENA SITES

	Hastie	South	Hadfield	Dartman
TSP	0.837	0.769	0.729	0.879
Arsenic	0.629	0.129	0.806	0.943
Cadmium	0.667	0.197	0.751	0.901
Copper	0.706	0.798	0.813	0.937
Lead	0.686	-0.047	0.787	0.811
Zinc	0.797	-0.067	0.507	0.412

23. Table 15 summarizes the trace metal data for the Firehall site. In 1984, the five trace metals sampled contributed 16.2 ug/m^3 to the TSP catch. That amounted to 21.6 percent of the total suspended particulates. Of all the East Helena sites, TSP collected at the Firehall had the highest percentage of each metal except zinc. Furthermore, lead made up 7.0 percent of the annual TSP concentration. The department believes that either direct or indirect emissions from the ASARCO smelter and the American Chemet plant are significantly impacting this site.
24. The department also performed cross-comparisons of TSP and trace metal data at the Firehall site. The results of the linear regression analyses are listed in Table 20. Lead correlated with TSP better than any of the other trace metals but even that correlation was poor. However, all the correlations were positive and statistically significant.
25. The cross-comparisons between the Firehall trace metal data provided results similar to those for the Hastie and Hadfield sites. Again, the

TABLE 20

CORRELATION COEFFICIENTS FOR TSP AND
TRACE METALS AT THE EAST HELENA FIREHALL SITE

	TSP	Arsenic	Cadmium	Copper	Lead	Zinc
TSP	---	0.455	0.251	0.340	0.527	0.105
Arsenic	0.455	---	0.587	0.057	0.879	0.346
Cadmium	0.251	0.587	---	0.014	0.642	0.274
Copper	0.340	0.057	0.014	---	0.149	0.049
Lead	0.527	0.879	0.642	0.149	---	0.443

best correlation was observed between lead and arsenic and the worst was observed between cadmium and copper. Apparently, arsenic and lead are associated with the same emission source, and cadmium and copper are not.

26. Table 19 shows the correlation coefficients between the Firehall trace metal data and trace metal data at the other East Helena sites. As with previously discussed sites, copper showed a good to excellent correlation with copper data from all other sites. In addition, copper was the only trace metal which correlated with similar data from the South site. In fact, lead and zinc data from the Firehall actually showed negative correlations with similar data from the South site. Taking an overall perspective of the trace metal comparisons, the department observed that the Firehall trace metals correlated very well with similar data from the Dartman Field site and well with the Hastie and Hadfield sites. However, with the exception of copper, there was no correlation with trace metals from the South site. The Firehall and Dartman Field sites seem to be influenced by the same or similar sources. The two sites are generally

located on a straight line from the American Chemet plant and the ASARCO smelter.

27. The department and ASARCO will continue to operate the Firehall site indefinitely to track the effectiveness of the lead and TSP control strategies.

28. The Dartman Field site is located in a field just north of East Helena. The site is about 0.75 miles from the ASARCO smelter complex.

29. During 1984, TSP levels at the Dartman Field site met all state and federal ambient standards. The geometric mean was 41 ug/m^3 and the highest twenty-four hour concentration was 174 ug/m^3.

30. TSP data from the Dartman Field site correlated very well with TSP from all other sites (see Table 21). The best correlation was observed with data from the Firehall site.

TABLE 21

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS
BETWEEN THE DARTMAN FIELD SITE AND OTHER EAST HELENA SITES

	Hastie	South	Firehall	Hadfield
TSP	0.830	0.835	0.879	0.831
Arsenic	0.571	0.315	0.943	0.858
Cadmium	0.694	0.193	0.901	0.677
Copper	0.875	0.858	0.937	0.973
Lead	0.671	0.070	0.811	0.794
Zinc	0.214	0.129	0.412	0.834

31. Table 15 lists the trace metal data for the Firehall site. Trace metals made up over 13 percent of the TSP and lead made up over 5 percent. Despite the fact that the Dartman Field site is located considerably farther from the ASARCO smelter and the American Chemet plant than many of the other sites, trace metals are still a significant part of the TSP catch.

32. The department compared the Dartman Field trace metal and TSP data with each other, and found that the lead data correlated well with TSP (see Table 22). The copper and arsenic data also displayed a fair correlation with TSP.

33. When the Dartman Field trace metals were compared with each other, the department found similar results to the previously mentioned sites. Again, arsenic and lead displayed the best correlations and cadmium and copper the worst.

TABLE 22

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS
AT THE EAST HELENA DARTMAN FIELD SITE

	TSP	Arsenic	Cadmium	Copper	Lead	Zinc
TSP	---	0.632	0.266	0.685	0.713	0.444
Arsenic	0.632	---	0.425	0.261	0.884	0.608
Cadmium	0.266	0.425	---	0.059	0.515	0.415
Copper	0.685	0.261	0.059	---	0.364	0.145
Lead	0.713	0.884	0.515	0.364	---	0.549
Zinc	0.444	0.608	0.415	0.145	0.549	---

34. The department also compared trace metal data from the Dartman Field site with similar data from the other East Helena sites. Copper showed a very good to excellent correlation with data from all of the other sites. With the exception of copper, none of the Dartman Field trace metals correlated with corresponding trace metal data from the South site.

35. Although TSP levels at the Dartman Field site are low, lead values are relatively high. The department will operate the Dartman Field site for at least another year.

36. The South site was located in a field approximately 0.75 miles south-southeast of the ASARCO smelter. The primary land use in the area is agriculture, although much of the land is unused open space. The site was operated primarily to determine lead concentrations resulting from the ASARCO stack and plant fugitive dust. Prevailing winds are from the west and northwest and, therefore, the South site is downwind of the smelter complex.

37. During 1984, TSP levels remained very low at the South site. The geometric mean was 34 ug/m^3 and the highest twenty-four hour reading was 98 ug/m^3. The TSP data was in compliance with all state and federal ambient standards.

38. TSP data from the South site correlated well with the Firehall and Hadfield sites and very well with the Hastie and Dartman Field sites (see Table 23). The good correlations with the other sites are somewhat surprising since the other three sites lie in the opposite direction from the smelter. The department considers this to be evidence that the major sources of TSP are areawide and not necessarily the smelter complex itself.

TABLE 23

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS
BETWEEN THE SOUTH SITE AND OTHER EAST HELENA SITES

	Hastie	Firehall	Hadfield	Dartman Field
TSP	0.845	0.769	0.761	0.835
Arsenic	-0.001	0.129	0.203	0.315
Cadmium	0.085	0.197	0.751	0.901
Copper	0.779	0.798	0.863	0.859
Lead	0.001	-0.047	0.072	0.070
Zinc	-0.104	-0.067	0.080	0.129

39. Table 15 shows the trace metal concentrations at the South site. In comparison with the other East Helena sites, the South site recorded the lowest concentrations of each of the trace metals. Trace metals made up only 5.6% of the TSP. Despite the site's downwind position from the smelter, the smelter complex does not appear to be a major TSP contributor.

40. The department compared the South site trace metals with the TSP data from the same site. The results are listed in Table 24. Zinc was the only trace metal which displayed even a fair correlation with TSP. Although zinc also showed the best correlation with TSP at the Hadfield site, lead prevailed at the other three sites. In general, the trace metals did not correlate as well with TSP at the South site. Apparently, the ASARCO smelter and American Chemet plant have less of an impact at this site.

41. The department also compared the South site trace metals with each other. The results of the linear regression analyses are given in Table 24. In

TABLE 24

CORRELATION COEFFICIENTS FOR TSP AND TRACE METALS
AT THE EAST HELENA SOUTH SITE

	TSP	Arsenic	Cadmium	Copper	Lead	Zinc
TSP	---	0.478	0.292	0.478	0.369	0.619
Arsenic	0.478	---	0.567	0.408	0.745	0.798
Cadmium	0.292	0.567	---	0.346	0.454	0.703
Copper	0.478	0.408	0.346	---	0.362	0.472
Lead	0.369	0.745	0.454	0.362	---	0.745
Zinc	0.619	0.798	0.703	0.472	0.745	---

contrast to the other East Helena sites, arsenic and zinc showed the best correlation. In fact, zinc showed fair to good correlations with all other trace metals except copper. Again, this is in direct contrast to data from the other sites. However, similar to the other sites, lead and arsenic also correlated well. Cadmium and copper exhibited the worst correlation although the correlation coefficient was somewhat better than at the other East Helena sites. The department observed that, in general, all of the trace metals correlated better with each other at the South site. The department believes that re-entrained fugitive dust contaminated with trace metals may be the main contributor to TSP at this site.

42. The department compared the South site trace metal data with similar data from the other East Helena sites (see Table 23). Similarly to all of the other sites, copper correlated well with data from all locations. Cadmium correlated well with data from the Hadfield site and excellently with the Dartman Field site. The department can't explain why cadmium showed an excellent correlation between the South and Dartman Field sites unless the

cadmium is emitted from the main stack. Both sites are located far enough from the smelter to be impacted by the main stack plume. All other trace metals showed poor correlations with trace metal data from the other sites.

43. The department shut down the South site in April, 1985. Although the South site appears to be impacted by a different set of emission sources, the TSP and lead concentrations were quite low. In an effort to save money on laboratory charges, the department shut down the site.

Montana City

1. Montana City was a late nineteenth century mining camp which has totally disappeared. However, the name Montana City has been kept alive and describes an I-15 interchange, a local grade school, and a store-bar-restaurant complex. The timbered hills to the south have been intensively subdivided over the past ten years for residential home sites.
2. The department has operated a high volume sampler on the roof of the Montana City School since February, 1982. The school is located approximately 0.3 miles west-southwest of the Kaiser Cement Plant and near the intersection of secondary highway 518 and the Saddle Mountain Road. The Saddle Mountain Road is unpaved and has an average daily traffic of approximately 600 cars. This road serves the expanding subdivisions on the slopes of Saddle Mountain.
3. Figure 34 identifies the location of the Montana City School site and Table 8 summarizes the associated TSP data.
4. TSP levels during 1984 were quite high and the geometric mean increased by 16 percent over 1983. The annual geometric mean of 78 ug/m^3 exceeded both the state and federal primary TSP ambient standards. The first and

second highest twenty-four hour readings were 349 ug/m^3 and 201 ug/m^3. These concentrations exceeded the state primary and the federal secondary standards, but met the federal primary standard.

5. The department suspects that the high TSP levels are caused by re-entrained dust off the Saddle Mountain Road and, to a lesser extent, emissions from the Kaiser Cement mine and plant. Wood smoke from nearby homes may also be a contributor during the winter season.
6. The department intends to operate this site for at least another year. The department will perform some very basic source apportionment work at the Montana City School site over the next twelve months. Based on the results, the department will develop control strategies to bring the area into compliance with ambient standards.

Anaconda

1. Anaconda is a city of 10,000 people situated at the south end of the Deer Lodge Valley. With the closure of the Anaconda Company smelter in 1980, the population of Anaconda has decreased and is expected to continue to decline. The department anticipates that particulate emissions will follow the the population trend, despite higher emissions from the various tailings ponds and demolition of the smelter complex.
2. Figure 36 is a map of Anaconda showing the locations of the various monitoring sites. Table 8 summarizes the particulate data.
3. The Lincoln School monitoring site is located in an older residential area just east of the city center. The department considers the Lincoln School site as the primary monitoring site in Anaconda.
4. During 1984, the geometric mean for TSP was 35 ug/m^3. The highest twenty-four hour value was 210 ug/m^3. There were no violations of any state or federal ambient standard at the Lincoln School site during 1984.

FIGURE 36

ANACONDA MONITORING SITES

1. Lincoln School Site
2. Highway Junction Site
3. Mill Creek Site

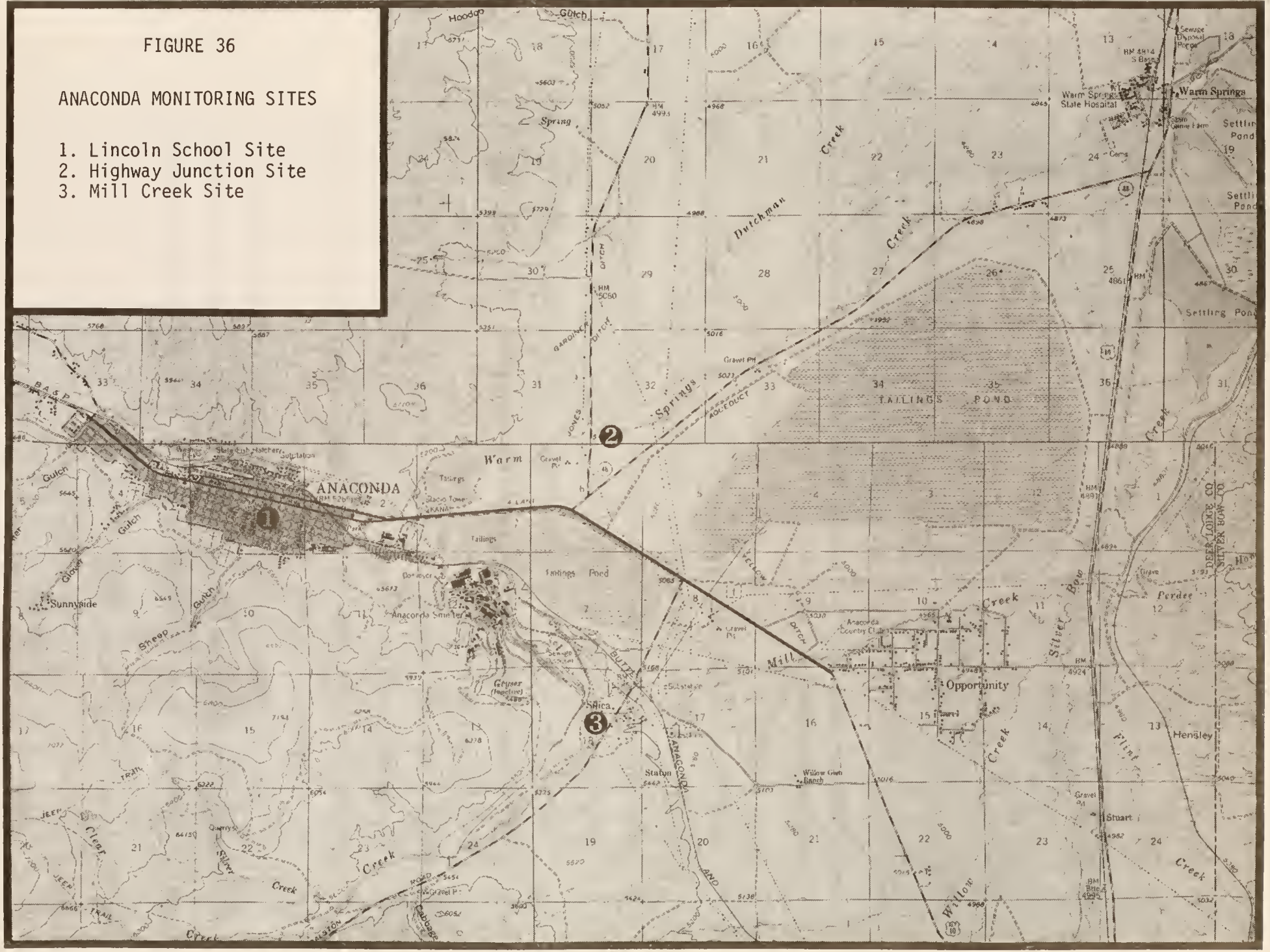


FIGURE 37

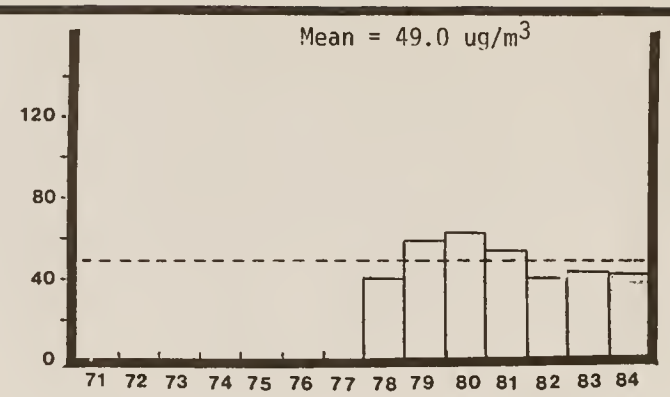
ANACONDA

LINCOLN SCHOOL
TREND ANALYSIS

Total Suspended Particulates

n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.107	No
Last 5 yr.	-.700	No



5. The department conducted a trend analysis on the TSP data from the Lincoln School sampler and the results are summarized in Figure 37. The results of the analysis indicated decreasing particulate levels over the seven year history of the site and especially over the last five years. However, the results for both periods were not statistically significant. The department notes that since the Anaconda smelter shut down in 1980, particulate levels have steadily decreased.
6. Despite low TSP readings, the department plans to continue to operate a high volume sampler at the Lincoln School site. The primary purpose of the site is to track arsenic concentrations during the demolition of the smelter and as the tailings ponds dry up.
7. The department re-established the Highway Junction site during July, 1984. The department reactivated the site in response to public complaints of blowing tailings and flue dust from the smelter demolition

project. The Highway Junction site is located near the intersection of Highways 10, 48 and 273. The site is about one mile northeast of the old smelter complex and two miles east of Anaconda. The Anaconda tailings ponds are one-fourth mile south of the site and the Opportunity tailings pond lies one mile to the east.

8. After one half year of monitoring for TSP, the geometric mean was 30 ug/m^3 while the arithmetic mean was 61 ug/m^3. The two means are significantly different due to an occasionally high twenty-four hour concentration. The occasional high levels drastically raised the arithmetic mean but had little effect on the geometric mean. The first and second highest twenty-four hour concentrations during 1984 were 825 ug/m^3 on December 29 and 480 ug/m^3 on December 14. These concentrations were the highest twenty-four hour TSP levels recorded in Montana during 1984.

9. The department reviewed the meteorological data for December 14 and 29, 1984, from the nearby Anaconda Company meteorological site at Johnson Curve and the Anaconda National Weather Service site. Both days were warm, dry and windy. The winds were from the south-southeast on both days and the average wind speed for December 14 was 21 mph. On December 29, it was 17 mph. Based on this information, the department speculates that the source of the particulates was windblown dust from the Anaconda tailings pond, the smelter area or the Anaconda sewage treatment plant construction site.

10. The department will operate the Highway Junction site for at least two more years. The primary purpose is to check arsenic concentrations in relation to the dismantling of the Anaconda smelter.

11. The Anaconda Company will continue to operate high volume samplers and inhalable particulate samplers at the Lincoln School, Mill Creek, and Johnson Curve sites. The Anaconda Company will analyze the filters for seven chemical elements.

Butte

1. The city of Butte is situated on the north end of the Summit Valley (5400 feet) and extends up the north hill to the city of Walkerville. The Anaconda Minerals Company shut down their Berkeley Pit copper mine and Weed Concentrator in July, 1983. The shutdown not only eliminated a major emission source of particulates, but also had a drastic effect on the local economy.
2. Figure 38 shows the location of the Butte sampling site. Table 8 summarizes the associated particulate data.
3. In 1983, the department reduced the Butte monitoring network from four sites to only the Greeley School site. The Greeley School is located near the lowest point in the valley (5430 feet). It lies in a residential area 0.3 miles from the Anaconda Company crusher and 0.6 miles from the Berkeley Pit. The department used the data from this site to designate the area nonattainment for primary TSP standards.
4. In 1984, the geometric mean for TSP at the Greeley School decreased 14 percent to 43 ug/m^3. The highest twenty-four hour readings were 193 ug/m^3 and 180 ug/m^3. The Greeley School data indicates compliance with Montana and federal primary standards, although the federal twenty-four hour secondary standard was exceeded. The department has submitted a request to EPA to redesignate the area to attainment for primary standards.

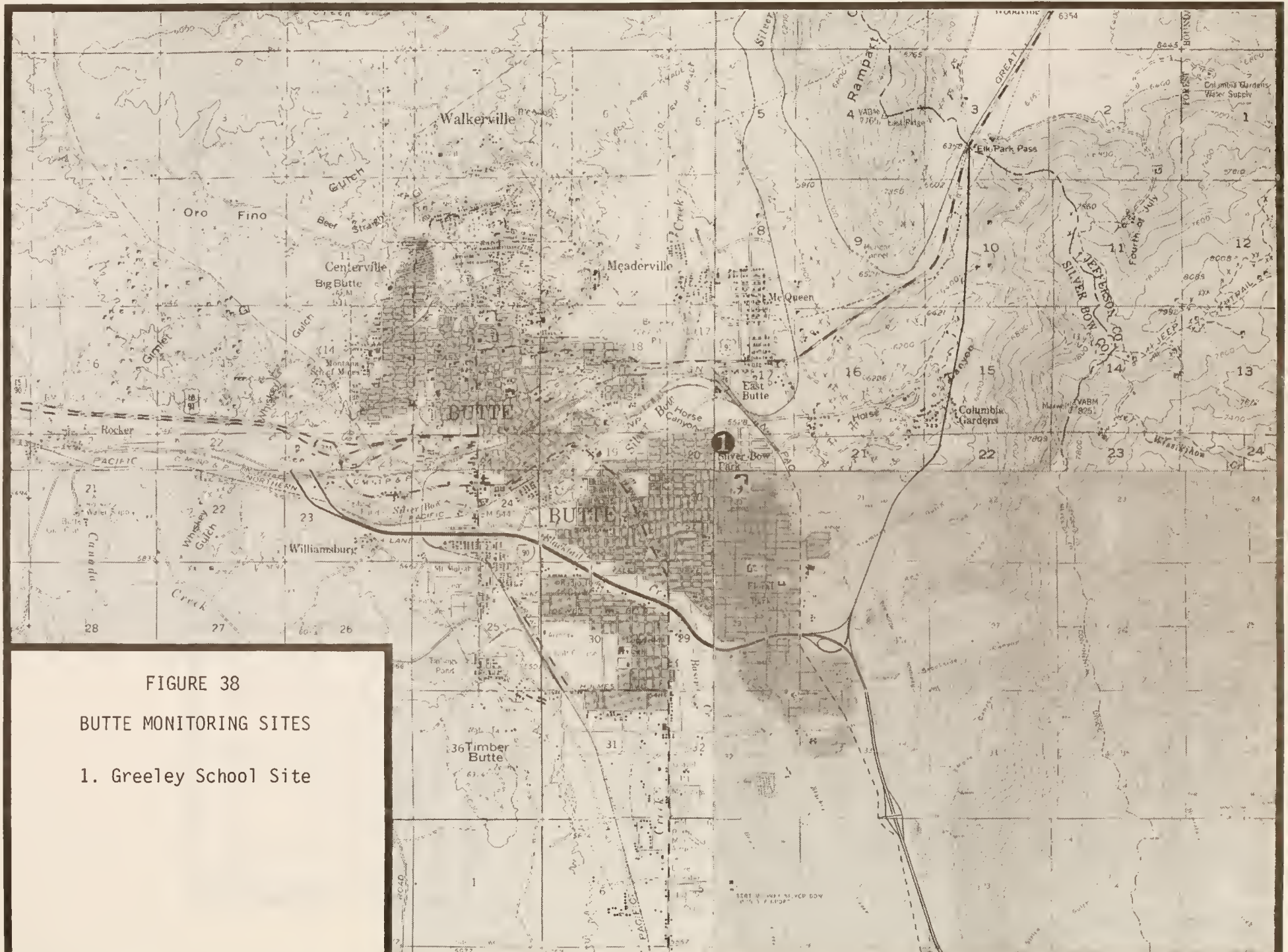


FIGURE 38

BUTTE MONITORING SITES

1. Greeley School Site

5. The department conducted a trend analysis on the Greeley School TSP data for the entire eleven year history of the site and for the past five years. The results showed statistically significant downward trends for both periods (Figure 39). The department concludes that air quality in Butte is definitely improving.

6. Since other areas of Montana now record higher TSP levels, the department has moved the Greeley School collocated sampler to Libby. The department intends to continue to operate the Greeley School site indefinitely. In addition, the department installed a PM-10 monitor during May, 1985.

Dillon

1. Dillon is a town of 4000 people set in the middle of the Beaverhead Valley. The valley floor is at 5400 feet above sea level with relatively low (6700 feet) rolling mountains located ten miles to the west. Although higher mountain ranges such as the Pioneer, Snow Crest and Ruby Ranges are

FIGURE 39

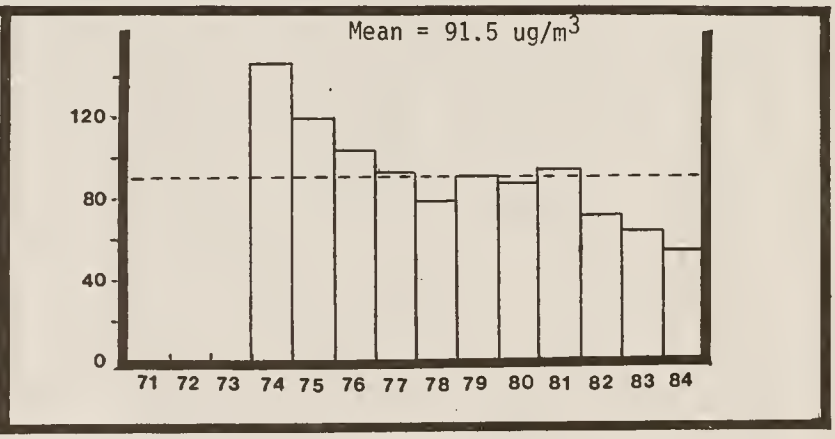
BUTTE

GREELEY SCHOOL
TREND ANALYSIS

Total Suspended Particulates

n> 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.882	Yes
Last 5 yr.	-.900	Yes



nearby, Dillon projects a wide open spaces image. The only major industrial emission sources in the area are the Pfizer talc plant and the Stoltze sawmill which are both located six miles south of town.

2. Figure 40 shows where the Dillon monitoring site is located and Table 8 summarizes the TSP data.
3. In accordance with the 1984 Network Review, the department installed a high volume sampler at the Beaverhead County Courthouse. The department started sampling in late September, 1984. The Beaverhead County Courthouse is located two blocks southeast of the downtown area and one-half block off the old highway. The sampler is located on the Courthouse roof about 20 feet above the ground.
4. The geometric mean for the last four months of 1984 was 38 ug/m^3 and the highest twenty-four hour reading was 57 ug/m^3. These readings are very low and indicate that Dillon does not have a particulate problem.
5. The department will operate the Dillon site until December, 1985, and then decide whether to shut it down or not.

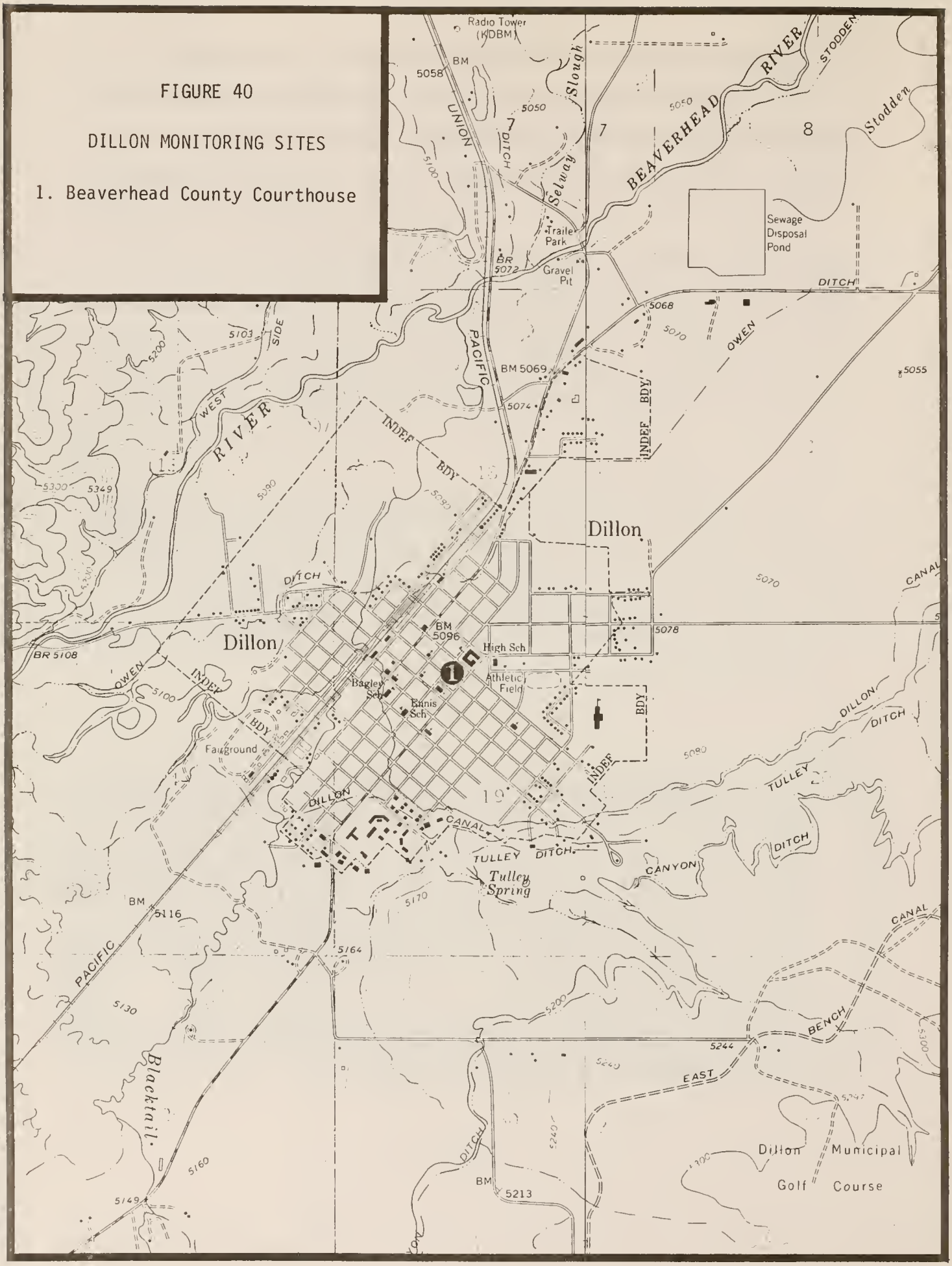
Bozeman

1. The city of Bozeman lies near the eastern edge of the Gallatin Valley at an elevation of 4800 feet above sea level. The Gallatin Valley experiences frequent temperature inversions. The department believes this phenomenon is aggravated by the confinement of surrounding mountains and a high rate of radiation surface cooling caused by the city's high elevation and persistent winter snow cover.
2. Figure 41 is a map showing the locations of the Bozeman sampling sites. Table 8 summarizes the associated TSP data.

FIGURE 40

DILLON MONITORING SITES

1. Beaverhead County Courthouse



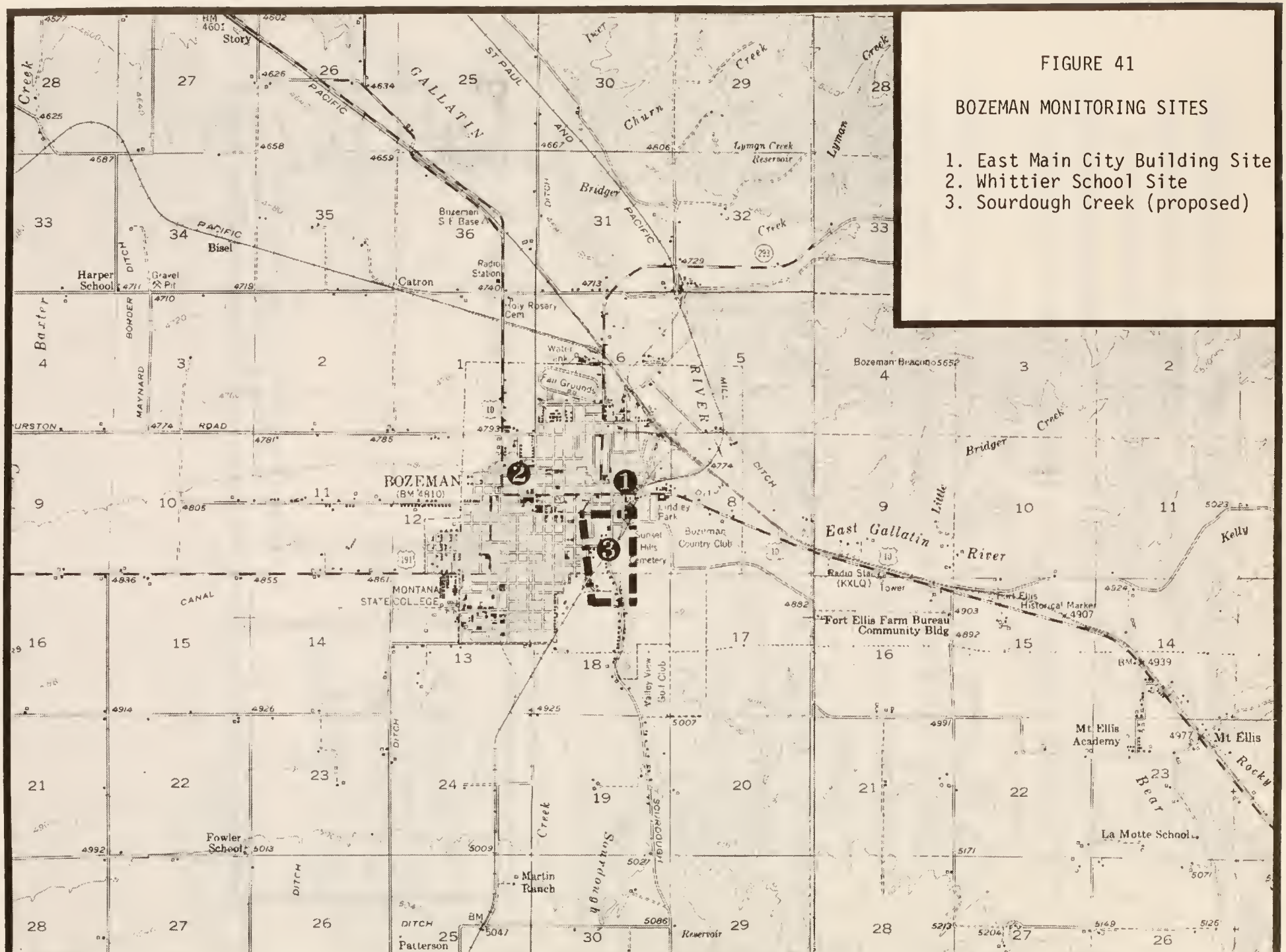


FIGURE 41
BOZEMAN MONITORING SITES
1. East Main City Building Site
2. Whittier School Site
3. Sourdough Creek (proposed)
BOZEMAN
(BM 4810)
MONTANA STATE COLLEGE
Bozeman Country Club
Valley View Golf Club
Lindley Park
Sunset Hills Cemetery
Fall Grounds
Water tank
Holy Rosary Cem
Radio Station
Bozeman S E Base
Catron
Harper School
Gravel Pit
Bisel
Story
Lyman Creek Reservoir
Bozeman Bracino 5652
Radio Station (KXLQ) Tower
Fort Ellis Historical Marker 4907
Fort Ellis Farm Bureau Community Bldg
Mt Ellis Academy
Mt Ellis
La Motte School
Martin Ranch
Patterson Ranch
Fowler School
Reservoir
Gallatin River
East Gallatin River
Bridger Creek
Churn Creek
Lyman Creek
Sourdough Creek
Rocky Bear
Kelly
Baxter
Maynard
Border Ditch
Canal
Ditch
Pacific and St Paul
Pacific
Gallatin
Hill
Road
Thurston

3. The East Main City Building site is the primary sampling site in Bozeman. The sampler is operated by the Gallatin County Health Department through a cooperative arrangement with the department. The East Main City Building is located one-half block north of Main Street near the east end of the central business district. The Hawthorne School lies directly to the north with an older residential area beyond.

4. The 1984 geometric mean at the East Main site was 69 ug/m^3. The highest individual reading was 198 ug/m^3. Although the federal primary standards were not exceeded, the Montana annual standard and the federal secondary standards were.

5. The department performed a trend analysis on the five years of TSP data available from the East Main site. The results indicated a decrease in TSP concentrations, but the decline was not statistically significant. Figure 42 graphically displays the results.

FIGURE 42

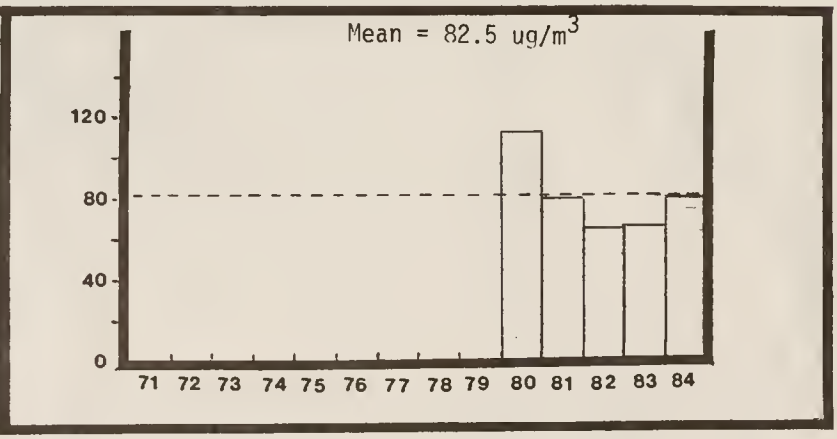
BOZEMAN

EAST MAIN CITY BUILDING
TREND ANALYSIS

Total Suspended Particulates

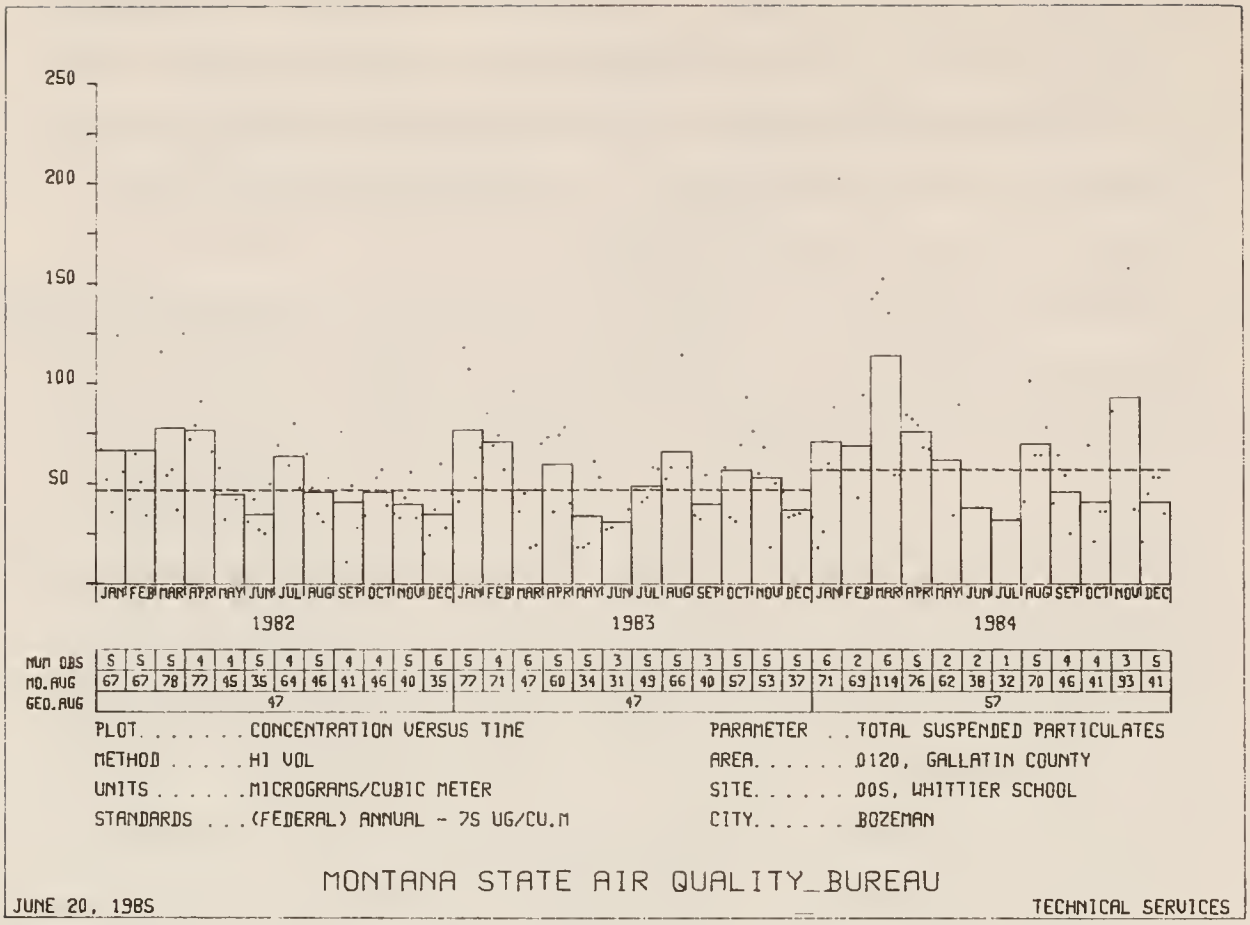
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.300	No



6. The department and the Gallatin County Health Department will continue to operate this site indefinitely. The department has recently upgraded the site by installing a permanent electrical outlet near the sampler. This will eliminate unexpected power losses caused by people unplugging the sampler to plug in their car heaters. The department also recently installed a PM-10 monitor at this site.
7. The Whittier School site is located on the west edge of a residential area and one block east of Seventh Avenue, which is a major arterial.
8. During 1984, TSP concentrations at the Whittier School site were up 21 percent from 1983. The geometric mean was 57 ug/m^3 and the highest twenty-four hour value was 202 ug/m^3. The data complied with all state and federal ambient standards except the federal secondary twenty-four hour standard. Figure 43 is a three year plot of monthly TSP concentrations at the Whittier School.
9. The department recently moved the Whittier School site to a new location in the Sourdough Creek area. The department and Gallatin County personnel are interested in monitoring in the Sourdough Creek area to establish TSP levels in a residential area with intensive residential wood burning. The area lies in a small valley along Sourdough Creek where light drainage wind tend to concentrate smoke. In addition, TSP levels at the Whittier School were lower than expected and access to the site was difficult and dangerous.

FIGURE 43

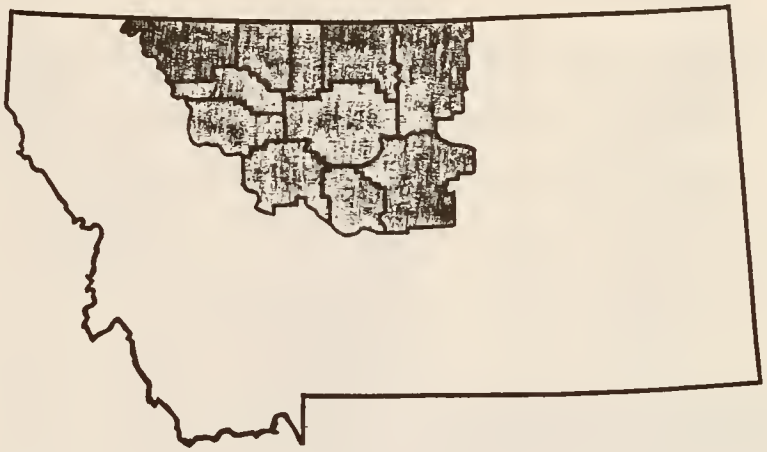

250
200
150
100
50
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1982
1983
1984
NUM OBS 5 5 5 4 4 5 4 5 4 4 5 6 5 4 6 5 5 3 5 5 3 5 5 5 6 2 6 5 2 2 1 5 4 4 3 5
MO.AUG 67 67 78 77 45 35 64 46 41 46 40 35 77 71 47 60 34 31 49 66 40 57 53 37 71 69 119 76 62 38 32 70 46 41 93 41
GEO.AUG 47 47 57
PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M
PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0120, GALLATIN COUNTY
SITE. . . . . 005, WHITTIER SCHOOL
CITY. . . . . BOZEMAN
MONTANA STATE AIR QUALITY BUREAU
JUNE 20, 1985
TECHNICAL SERVICES

Prospective Sites

The department will add West Yellowstone to its list of prospective sites even though we have no immediate plans to install a monitor. Funding is just not available at this time. The West Yellowstone area is a major tourist area, serving as the west entrance to Yellowstone National Park. The department suspects that residential wood burning and re-entrained road dust may be causing elevated TSP concentrations.

NORTH CENTRAL

MONTANA



Northcentral Montana includes the area from Havre and Lewistown west to the Rocky Mountain Front. This region is primarily a high plain used for growing wheat and barley and for grazing cattle. The plain is occasionally interrupted by river and stream drainages and several outlying mountain ranges such as the Bear Paw, Highwood, and Judith Mountains. The climate is hot and dry in the summer and cold and dry in the winter. The notorious "chinook" winds are very prevalent in this area during the late fall and winter. Temperature inversions are infrequent and dispersion conditions are usually good.

Great Falls

1. The Cascade County Health Department operates four high volume sampling sites in Great Falls. The city of Great Falls lies along the banks of the Missouri River near the western edge of the Northern Great Plains. High concentrations of air pollutants are uncommon in Great Falls due to persistent winds.

2. Figure 44 shows the Great Falls sites and Table 8 summarizes the associated data.

3. The Great Falls Fire Station site is located on the southern edge of the downtown central business district. Since the prevailing winds are from the southwest, this site is generally upwind of the downtown area.

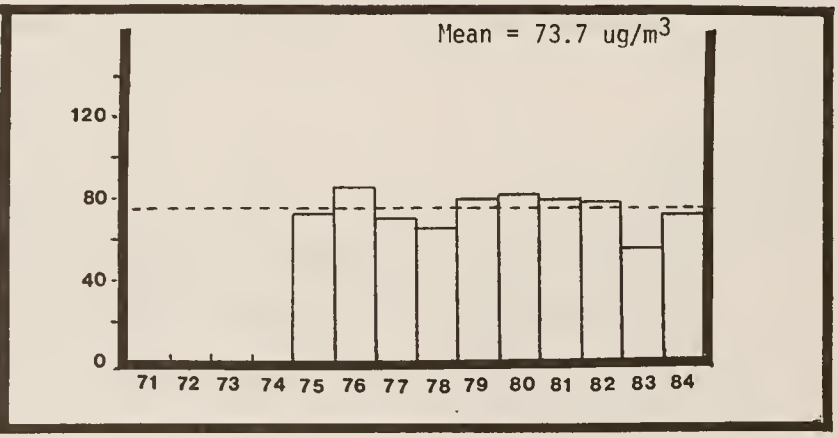
4. The Fire Station recorded the highest geometric mean (66 ug/m^3) for total suspended particulate of any of the Great Falls sites. The highest twenty-four hour reading was 175 ug/m^3. The TSP levels at the Fire Station site were in compliance with state and federal primary ambient standards. However, the federal secondary standards were exceeded.

5. The department conducted a trend analysis on the data from the Fire Station site. The results are summarized in Figure 45. The analysis showed a decrease in TSP over both the past five years and the ten year history of the site. However, only the decline of the past five years was statistically significant.

FIGURE 45

GREAT FALLS
FIRE STATION
TREND ANALYSIS
Total Suspended Particulates
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.249	No
Last 5 yrs.	-.900	Yes



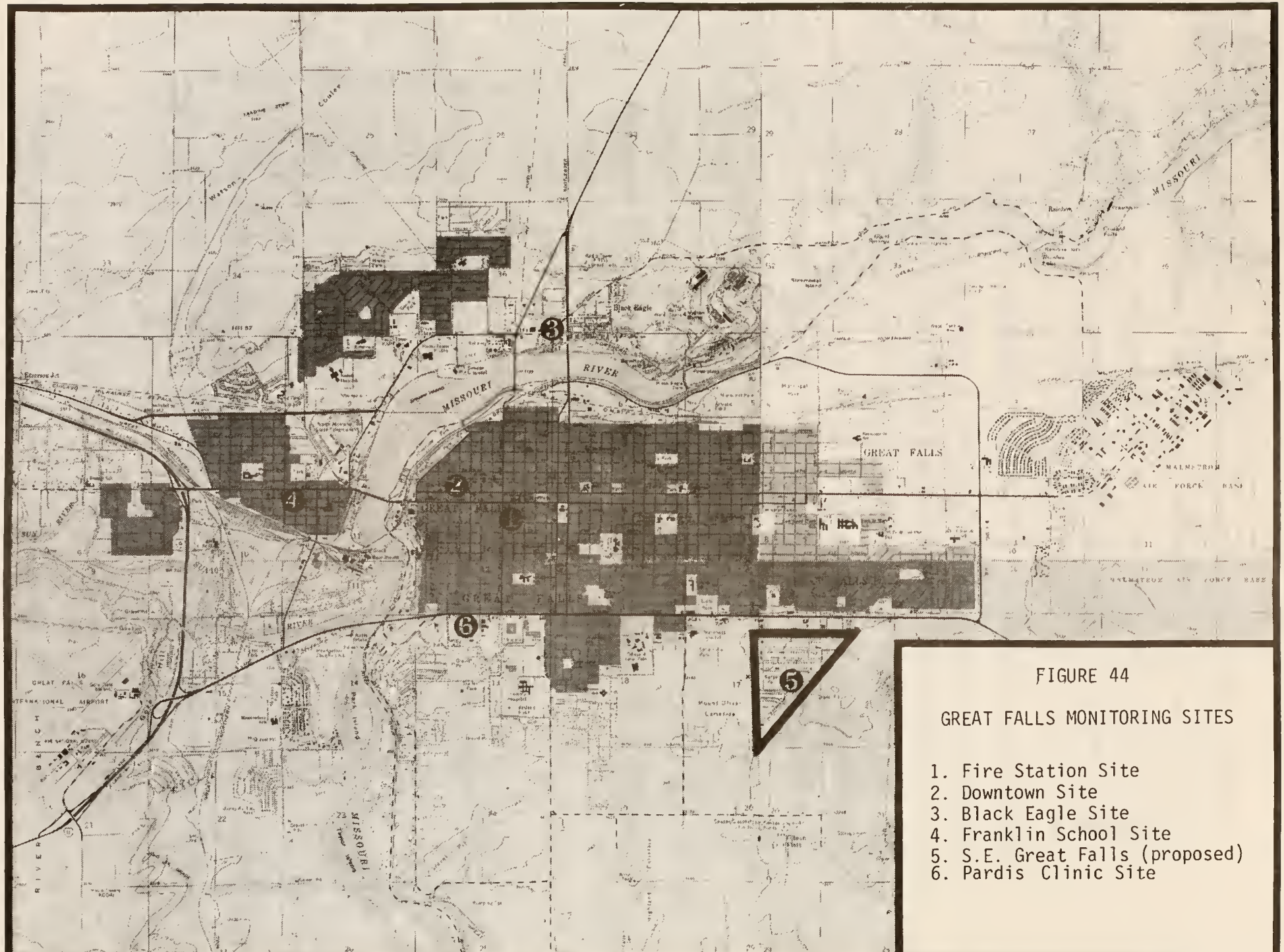


FIGURE 44

GREAT FALLS MONITORING SITES

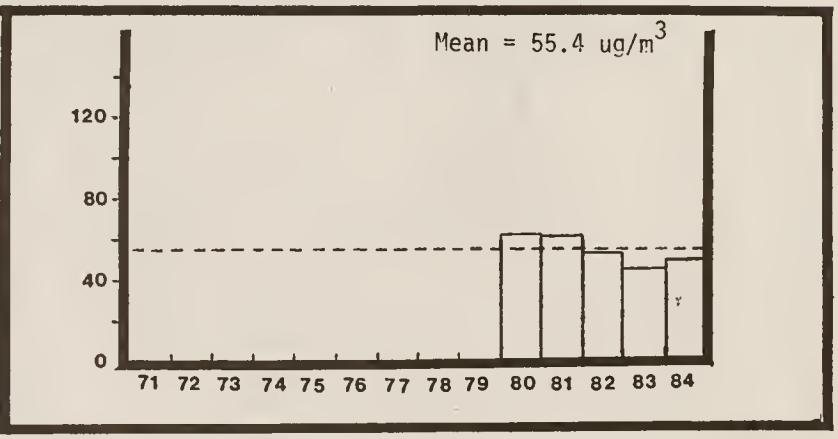
1. Fire Station Site
2. Downtown Site
3. Black Eagle Site
4. Franklin School Site
5. S.E. Great Falls (proposed)
6. Pardis Clinic Site

6. The Cascade County Health Department will continue to operate the Fire Station monitor for the foreseeable future. The site usually records the highest concentrations in Great Falls and is essential for tracking the city's progress toward meeting secondary standards.
7. Cascade County operates a collocated TSP monitoring site on the roof of the library. This NAMS site is known as the Downtown site and is located just north of the downtown business district.
8. In 1984, the geometric mean increased 9 percent to 46 ug/m^3. TSP levels are quite low and meet all state and federal ambient standards.
9. The department performed a trend analysis on the five years of TSP data from the Downtown site. The results are displayed graphically in Figure 46. The results indicated a downward trend which was statistically significant.
10. The County will continue to operate the Downtown site, mainly because it is a NAMS site. Otherwise, the low concentrations don't warrant further monitoring. In addition, a PM-10 monitor has recently been installed.

FIGURE 46

GREAT FALLS
DOWNTOWN
TREND ANALYSIS
Total Suspended Particulates
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.900	Yes



11. The Franklin School site was located on the west side of the Missouri River in an area that had previously gone unmonitored. The site operated almost two years and readings were very low (geometric means of 43 and 34 ug/m^3). Due to the very low readings, the site was shut down in April, 1984.

12. The Black Eagle station is located north of the Missouri River in a predominantly industrial area. The Montana Refining Company oil refinery is located 0.5 mile to the west and the closed ARCO copper refinery is 1.0 mile to the east. The surrounding area has poorly maintained roads and very little vegetative cover. Although the majority of the demolition at the copper refinery was accomplished in 1982 and 1983, some work continued through 1984.

13. The TSP levels at the Black Eagle Post Office were essentially the same as in 1983. The geometric mean was 56 ug/m^3 and the highest individual reading was 175 ug/m^3. The data from the site complied with all state and federal ambient standards.

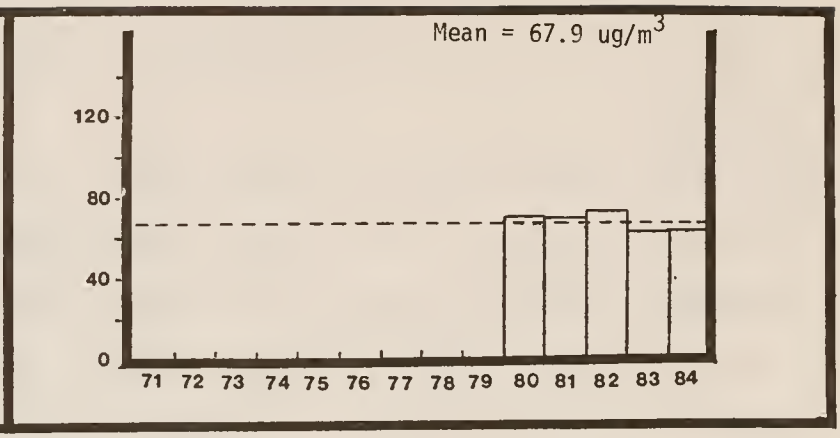
14. The department also performed a trend analysis on the TSP data for the past five years at the Black Eagle site (see Figure 47). Again, the results showed a decrease in TSP. However, the decrease was not statistically significant. Still, all three sites studied in Great Falls showed decreases in TSP and two of the three had statistically significant decreases.

15. Cascade County will continue to operate the Black Eagle site for at least one more year. When the demolition of the ARCO copper refinery is complete, the data will be reviewed again to decide the future of the site.

FIGURE 47

GREAT FALLS
BLACK EAGLE
TREND ANALYSIS
Total Suspended Particulates
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.600	No



16. The Cascade County Health Department plans to install a high volume sampler in the southeast part of the city. The area is experiencing residential growth and perhaps increases in particulate emissions.

Choteau

The department moved the BLM Malta site to the south fork of the Teton River 30 miles northwest of Choteau, Montana. The sampler is located in a grassy area on the grounds of the Circle 8 Guest Ranch. The surrounding area is very mountainous and free of emission sources. The sampler was installed during April, 1985, to establish baseline concentrations and to monitor future oil and gas development. Figure 48 shows the location of the Circle 8 Guest Ranch.

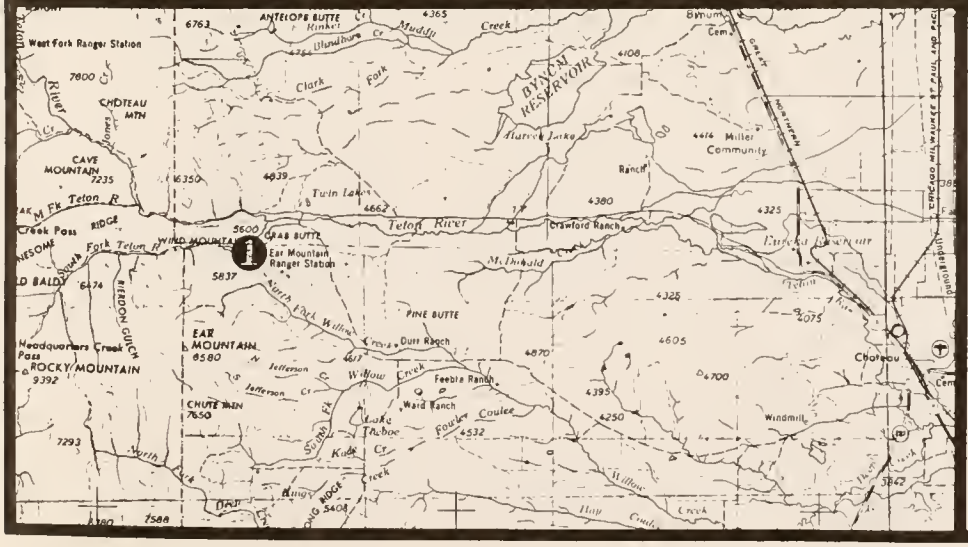


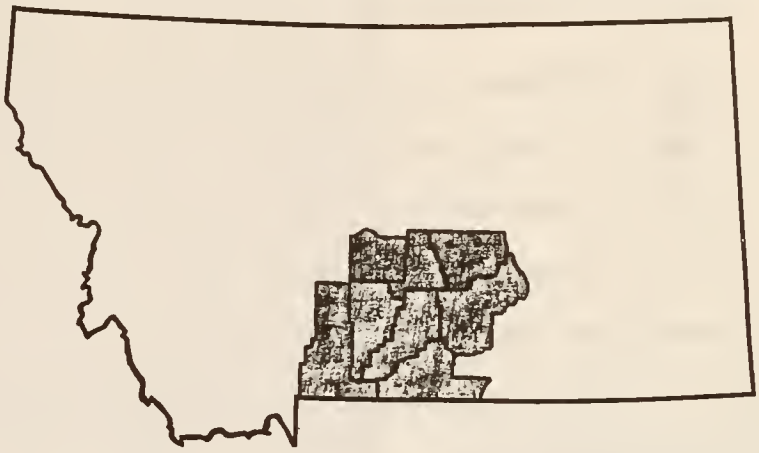
FIGURE 48

CHOTEAU MONITORING SITES

1. Circle 8 Guest Ranch Site

SOUTH CENTRAL

MONTANA



Southcentral Montana includes Park, Sweetgrass, Wheatland, Golden Valley, Stillwater, Carbon, Musselshell, Yellowstone, and Bighorn Counties. The area is quite similar to northcentral Montana in regard to climate and physical features. The Yellowstone River, however, has carved a major valley from Livingston to east of Billings. The high mountains just north of Yellowstone National Park also are unique to this region.

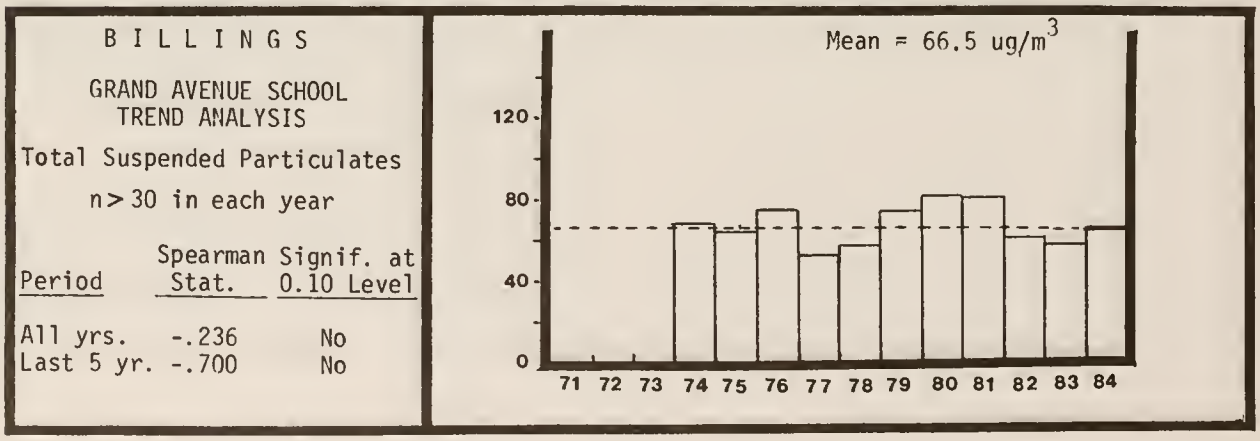
Billings

1. Billings is located in the bottom of the Yellowstone Valley at an elevation of 3100 feet above sea level. On the north and south edges of the valley, the rimrocks rise abruptly to a height of about 600 feet above the valley. The Yellowstone Valley is approximately ten miles wide near Laurel (12 miles west-southwest of Billings) but the rimrocks form a constriction in the valley at the eastern edge of Billings. The constriction is about one mile wide and separates Billings from the Lockwood area. The prevailing winds are from the southwest and are channeled down the

Yellowstone Valley. Although the winds are usually responsible for good atmospheric dispersion, the 1981-1982 Billings sulfur dioxide study indicated that temperature inversions are quite frequent.

2. Figure 49 shows the locations of the Billings area monitoring sites while Table 8 summarizes the associated data.
3. The Yellowstone County Air Pollution Control Agency operates a high volume sampler at the Grand Avenue School. The sampler is on the roof of the school just south of Grand Avenue and the associated commercial strip development.
4. During 1984, TSP levels at the Grand Avenue site increased 7 percent to a geometric mean of 58 ug/m^3. The highest twenty-four hour concentration was relatively low at 138 ug/m^3. The 1984 TSP data from the Grand Avenue School was in compliance with all state and federal ambient standards.
5. The department performed a trend analysis on the TSP data from the Grand Avenue site. Although the analysis indicated a decrease in TSP over the past five years and the eleven year history of the site, the declines were not statistically significant. Figure 50 displays the results of the Grand Avenue trend analysis.

FIGURE 50



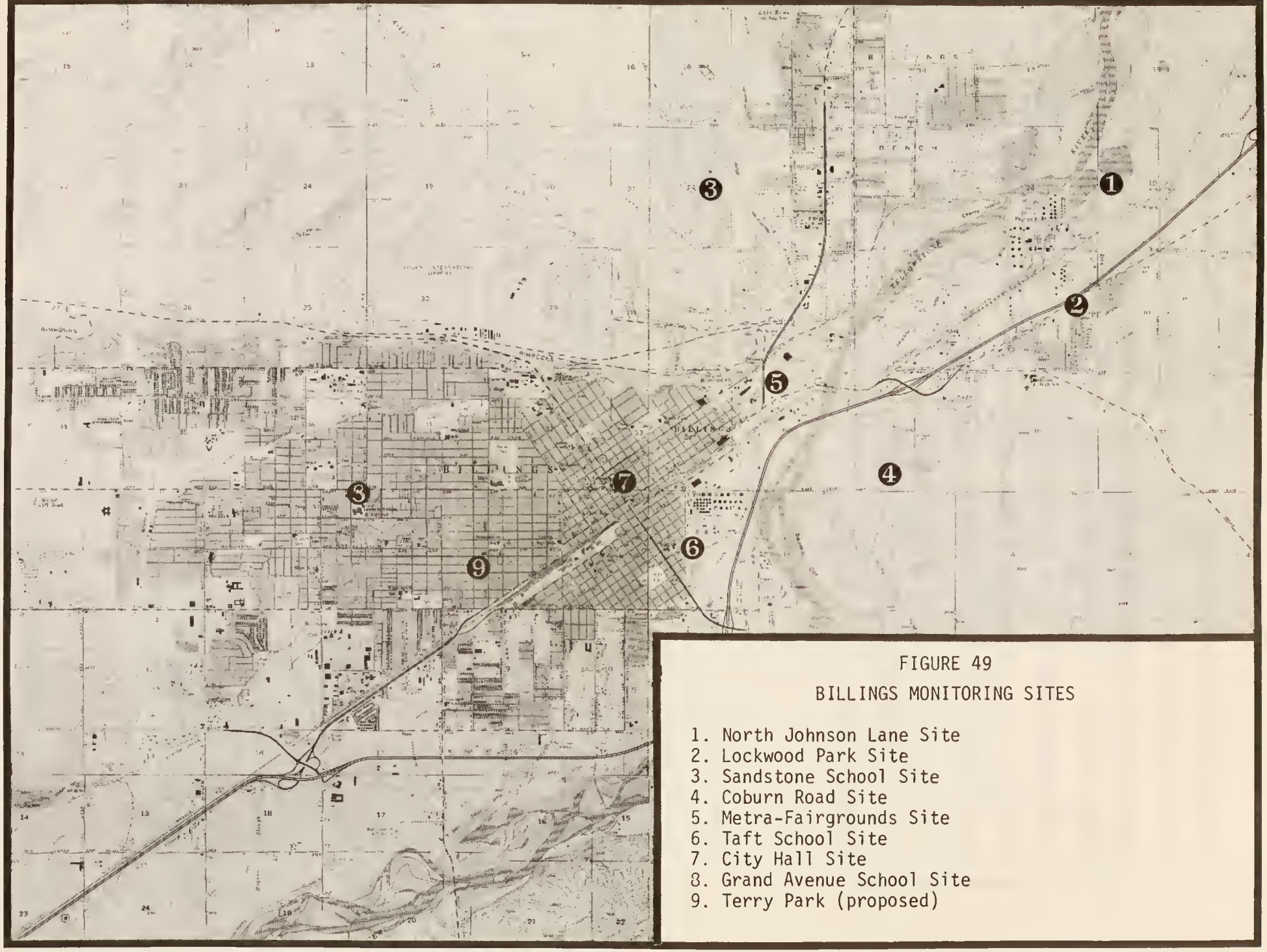


FIGURE 49

BILLINGS MONITORING SITES

1. North Johnson Lane Site
2. Lockwood Park Site
3. Sandstone School Site
4. Coburn Road Site
5. Metra-Fairgrounds Site
6. Taft School Site
7. City Hall Site
8. Grand Avenue School Site
9. Terry Park (proposed)

6. Yellowstone County personnel intend to shut down the Grand Avenue site. The TSP concentrations were relatively low during 1984 and access to the site is difficult. In addition, the site would need improvements to meet siting criteria. Yellowstone County intends to move the sampler to either the Meadowlark School or the Arrowhead School. Both locations are in west Billings where rapid commercial and residential development is taking place. On the other hand, Yellowstone County intends to move the Taft School monitoring shelter to the track area near the Grand Avenue School. The site would then meet all TSP siting criteria and could be used in the future to monitor carbon monoxide.

7. The City Hall site is located on the City Hall in downtown Billings. This site was responsible for the nonattainment designation of the central business district. Emission inventories and associated modeling performed in 1977 by PEDCo-Environmental, Inc., as part of the SIP revision showed that road dust from paved roads was the major contributor to TSP at the City Hall site. A factor analysis described in the 1981 Network Review also identified road dust as the major source influencing the site.

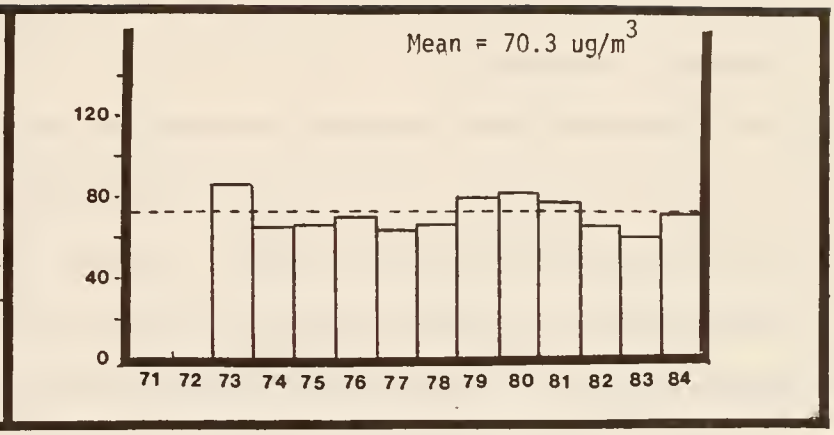
8. The TSP geometric mean at the City Hall site increased 14 percent during 1984 to 63 ug/m^3. TSP levels at the City Hall site met all state and federal ambient standards except for the federal secondary annual standard.

9. Figure 51 graphically displays the results of a trend analysis conducted by the department. The results indicate decreases in particulates over the past five years and the twelve year history of the site. However, the declines were not statistically significant. Yet the department and Yellowstone County are encouraged by the apparent improvement in

FIGURE 51

BILLINGS
CITY HALL
TREND ANALYSIS
Total Suspended Particulates
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	-.049	No
Last 5 yr.	-.700	No



particulate levels and anticipate that the federal secondary standards will be met.

10. Yellowstone County personnel will operate the City Hall site indefinitely. The site is essential for tracking the effectiveness of the nonattainment control strategies. In addition, a PM-10 monitor will be installed during July, 1985. The department will also designate the City Hall site a NAMS site on January 1, 1986.

11. The Taft School site is a collocated NAMS site located in an older residential area and near a major industrial district comprised of the Conoco Refinery, the Western Sugar Company, and the Montana Power Company, Corette Plant. In recent years, a trend has developed toward demolishing the older homes in the area and building commercial buildings.

12. During 1984, the Taft School site recorded the highest geometric mean and twenty-four hour readings in Billings. The geometric mean was 69 ug/m^3,

up 23 percent from 1983. The TSP data at the Taft School was in compliance with the state twenty-four hour standard and the federal primary standard but violated the state annual standard and the federal secondary standards.

13. The department turned over the operation of the Taft School site to the County in July, 1985. The department quit monitoring sulfur dioxide at the Taft School in December, 1983. Since TSP is the only parameter being monitored at the Taft School and the County is responsible for particulate monitoring in Billings, it was appropriate to transfer the responsibility to them. Since Yellowstone County is already operating collocated samplers at the City Hall, they shut down the collocated high volume sampler at Taft School in July, 1985. The County intends to move the site to the track at the Grand Avenue School early in the fall of 1985. Since the Taft School area is currently undergoing drastic changes from a residential area to a commercial/industrial area, the County believes monitoring should be terminated in the area until the conversion is complete. Monitoring during the conversion would be biased by emissions from construction activities.

14. The department operates a TSP sampler at the Lockwood Park site in conjunction with a sulfur dioxide analyzer. The Lockwood Park site is located in the northwest corner of the Lockwood Little League Park. The park is near the center of the Lockwood area and approximately 0.5 mile south-southeast of the Exxon Refinery and the Montana Sulphur and Chemical Company.

15. The department installed the Lockwood Park high volume sampler in July, 1983. The geometric means for TSP were 60 ug/m^3 in 1983 and 53 ug/m^3 in

1984. The data was in compliance with all state and federal ambient standards except for the federal secondary twenty-four hour standard.

16. The department will continue to operate a high volume sampler at the Lockwood Park site as long as sulfur dioxide is monitored at this site. In addition, the TSP concentrations are moderately high and this is the only site in the Lockwood area.
17. Yellowstone County operates a high volume sampler at the Sandstone School in the Billings Heights area. This site was installed in December, 1982, on a recommendation by the department. The objective of the site was to monitor TSP in a rapidly expanding area of Billings.
18. The County has gathered two years of data and the TSP levels are very low. The geometric means were 28 ug/m^3 in 1983 and 30 ug/m^3 in 1984. The highest twenty-four hour value was 108 ug/m^3. The data from this site easily met all state and federal ambient standards.
19. Despite the low TSP concentration, Yellowstone County will continue to operate the Sandstone School site.
20. Yellowstone County would also like to install a high volume sampler at a purely residential site such as Terry Park.

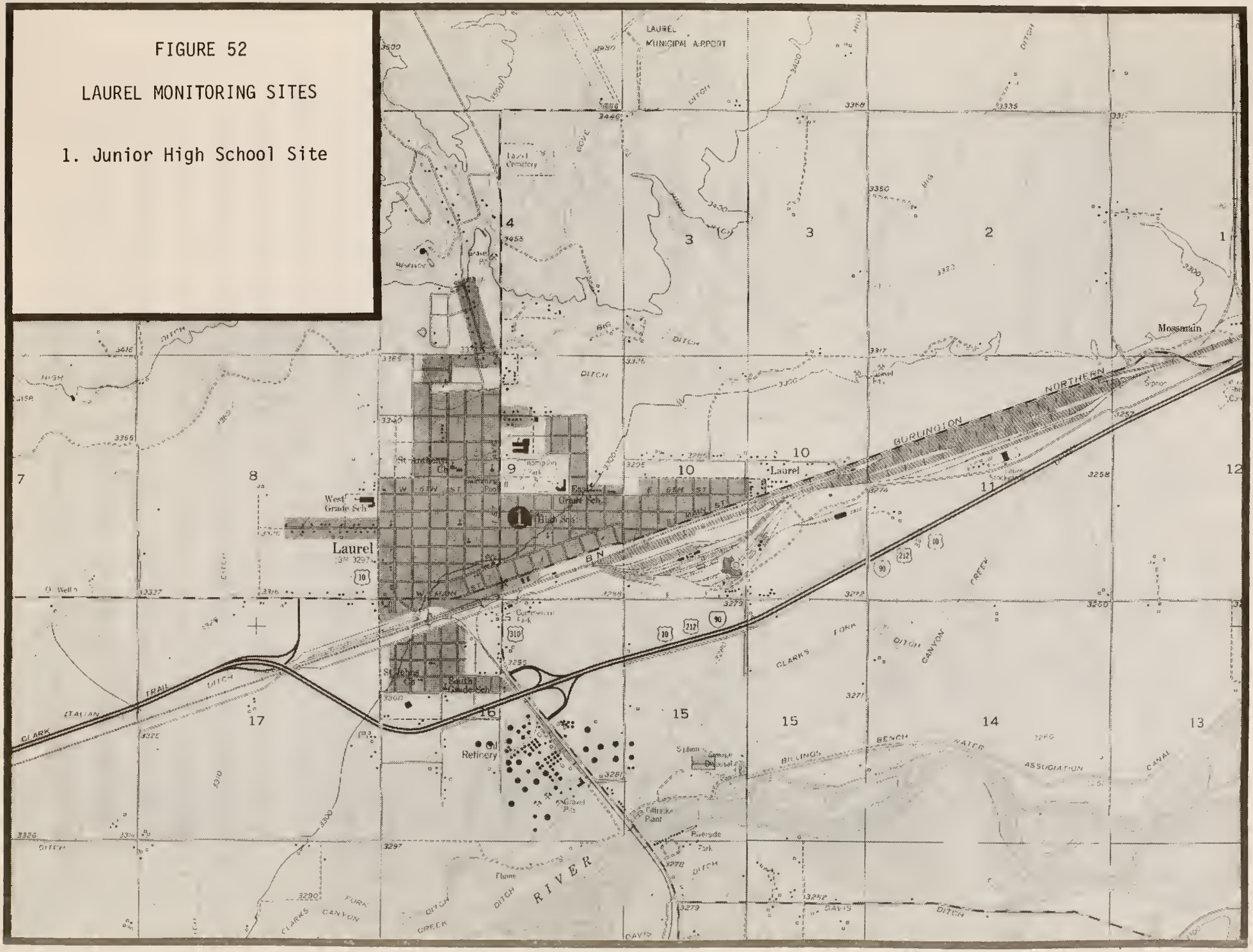
Laurel

1. Laurel is a small town of 5500 people located in the Yellowstone Valley twelve miles upstream from Billings. The CENEX oil refinery is located on the south edge of town. Laurel seems to enjoy slightly better dispersion than Billings, probably because the Yellowstone Valley is wider at this location.
2. Figure 52 is a map showing the location of the Laurel monitoring site. Table 8 summarizes the associated TSP data.

FIGURE 52

LAUREL MONITORING SITES

1. Junior High School Site



3. The Yellowstone County Air Pollution Control Agency operates a high volume sampler at the Laurel Junior High School. The TSP concentrations are very low in Laurel, registering a geometric mean of 37 ug/m^3 in 1984.
4. The department performed a trend analysis on the TSP data from this site for the past five years and the twelve year history of the site. The results of the analysis are described in Figure 53. Although the analysis showed an increase in TSP over the entire twelve year period, it showed a decrease over the past five years. Neither the increase nor the decrease were statistically significant.
5. Yellowstone County personnel intend to continue to operate this site.

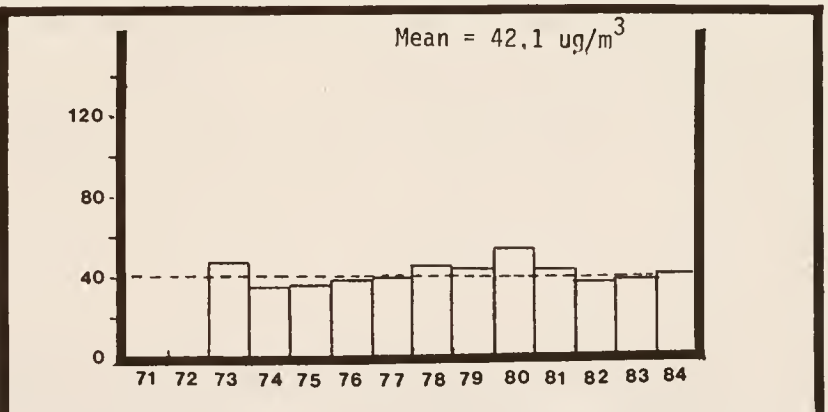
Prospective Sites

The department would like to install a TSP sampler in Livingston. Although dispersion is usually very good in Livingston, the population of the city is almost 7000 people and TSP has never been monitored in the area. Since funding is not available at this time, the department will list it as a prospective site for future consideration.

FIGURE 53

LAUREL
JUNIOR HIGH SCHOOL
TREND ANALYSIS
Total Suspended Particulates
n > 30 in each year

Period	Spearman Stat.	Signif. at 0.10 Level
All yrs.	+.077	No
Last 5 yr.	-.600	No



EASTERN

MONTANA

The department defines this area of Montana as the entire state east of a north-south line from just west of Malta to just east of Billings. This area actually includes over a third of the state. The area is almost exclusively flat to rolling plains which are occasionally interrupted by small stream and river valleys. The primary land uses are growing small grains and livestock grazing. The flatness of the area provides almost no obstruction to the prevailing west winds and ventilation is usually excellent.

Several years ago, the department started a program to monitor TSP in each of eastern Montana's larger communities. Sites were established in Miles City, Glendive and Sidney. The Miles City site was discontinued in 1983 due to low readings.

Malta and Plevna

1. The Bureau of Land Management contracted the department to operate background sites at a location near Plevna in southeastern Montana and on

the Bowdoin National Wildlife Refuge near Malta. Both sites were part of the original BLM network established in 1981. The Plevna site was started again in January, 1983, while the Malta site commenced operation in August, 1983.

2. The Malta site recorded a TSP geometric mean of 13 ug/m^3 during 1984. This is very low but typical of a background site. At the request of the BLM, the department shut down the site and moved it to the Circle 8 Guest Ranch 30 miles northwest of Choteau. The reason for the move was to monitor in the Rocky Mountain Front in an area of active oil and gas exploration. The Choteau site started operation in April, 1985.
3. Figure 54 shows the locations of the Malta and Plevna sites and Table 8 summarizes the data.
4. The Plevna site was plagued by equipment failures, animal damage, and operator problems during all of 1984. As a result, only five valid twenty-four hour readings were obtained. The Miles City office decided not to renew the contract and the site was shut down in December, 1984.

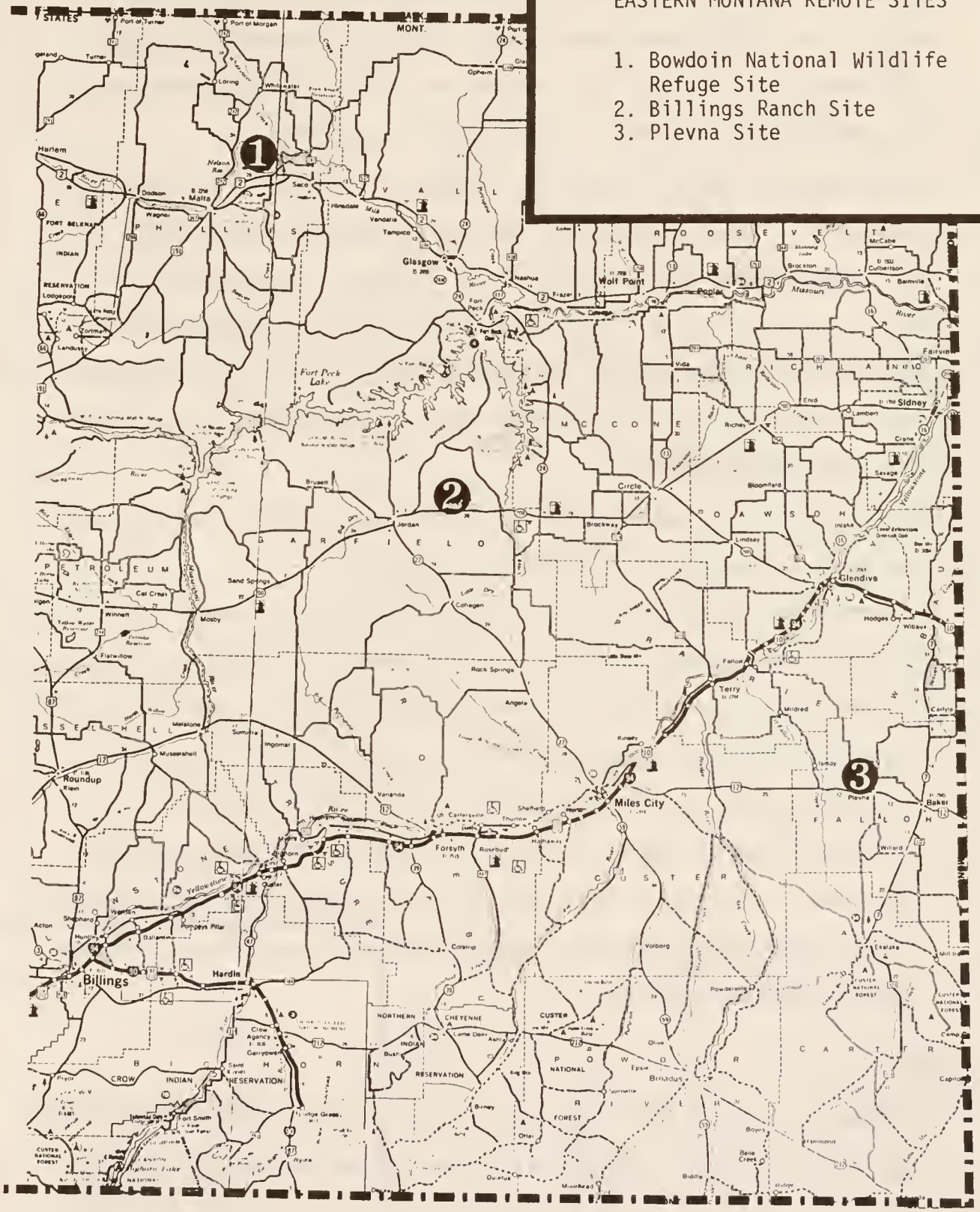
Jordan

1. The department has operated a TSP background site at the Billings Ranch near Jordan, Montana, since June, 1982. During 1984, the operator did not have the time to run the sampler and data recovery was limited to eight samples. Since no other prospective operators lived within reasonable driving distance of the site, the department dismantled it in April, 1984.
2. Figure 54 shows the location of the Jordan site and Table 8 summarizes the data.
3. The department does not intend to operate a new eastern Montana background site until additional funding becomes available.

FIGURE 54

EASTERN MONTANA REMOTE SITES

1. Bowdoin National Wildlife Refuge Site
2. Billings Ranch Site
3. Plevna Site



Scobey

1. Scobey is a small community of 1500 people located in extreme northeastern Montana. It lies 14 miles south of the Canadian Border and 22 miles south of the Saskatchewan Power Company electrical generating facility. The power plant consists of two 300 megawatt coal-fired generating units. The power plant became fully operational in July, 1983.
2. The Montana Legislature funded the Scobey air monitoring project through June, 1985. They also authorized the use of Legacy Fund money for a scaled-down project during the FY 86-87 biennium. The department shut down all air monitoring in the Scobey area on June 30, 1985, except for a network of sulfation plates. Sulfur dioxide and particulate monitoring may be restarted for a six to twelve month period in 1987, when Legacy Fund money becomes available.
3. Figure 55 is a map showing the locations of the Scobey monitoring sites and Table 8 summarizes the associated TSP data.
4. The department operated three TSP monitors in the Scobey area: one at the Canadian Border (Border), one 13 miles northeast of Scobey (Hanrahan), and the other just north of town (Richardson). Although the sites were installed to monitor the emissions from the power plant, they were primarily impacted by fugitive dust from agricultural activity.
5. During the last six months of 1984, TSP levels at all three sites were very low. The geometric means ranged from 16 ug/m^3 at the Border site to 19 ug/m^3 at the Hanrahan site. None of the sites violated any state or federal ambient standards.

Sidney

1. Sidney is a city of 5700 people which experienced a strong economic upturn during the late 70's and the early 80's. Oil and gas exploration and

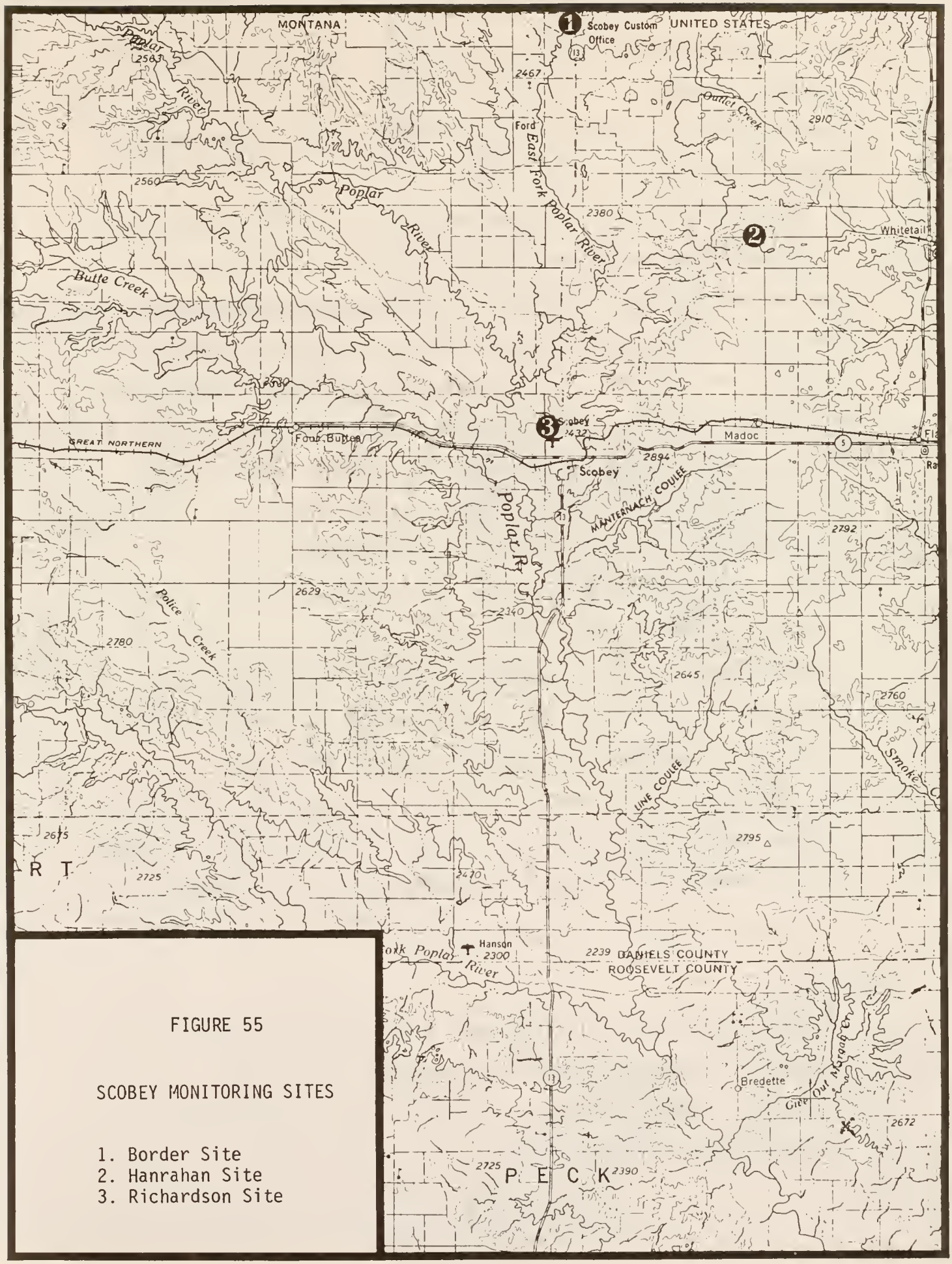


FIGURE 55

SCOBEY MONITORING SITES

1. Border Site
2. Hanrahan Site
3. Richardson Site

development in the Williston Basin peaked about that time and has since returned to normal.

2. Figure 56 locates the Sidney monitoring site and Table 8 summarizes the associated TSP data.
3. In light of this activity, the department installed a high volume sampler in downtown Sidney during January, 1983. The site has operated for two years and the TSP levels are higher than other eastern Montana sites. The 1984 geometric mean was 68 ug/m^3 and the highest twenty-four hour concentration was 233 ug/m^3. The arithmetic mean of 77 ug/m^3 violated the state annual standard. The geometric mean was in compliance with the federal primary standard, but exceeded the secondary standard. In addition, the federal secondary twenty-four hour standard was exceeded.
4. The department's chemistry laboratory analyzed the Sidney filters for sulfates and nitrates. The department thought that sulfates would be indicative of the emissions from the nearby oil and gas activity. The arithmetic mean for sulfates during 1984 was 4.7 ug/m^3 or about 6 percent of the TSP. On August 3, 1984, a sulfate concentration of 13.4 ug/m^3 was recorded. The department considers these values near normal.
5. The department will operate this site at least another year. The department ceased analyzing filters for sulfates and nitrates in January, 1985. If high concentrations continue, the department will investigate possible sources.

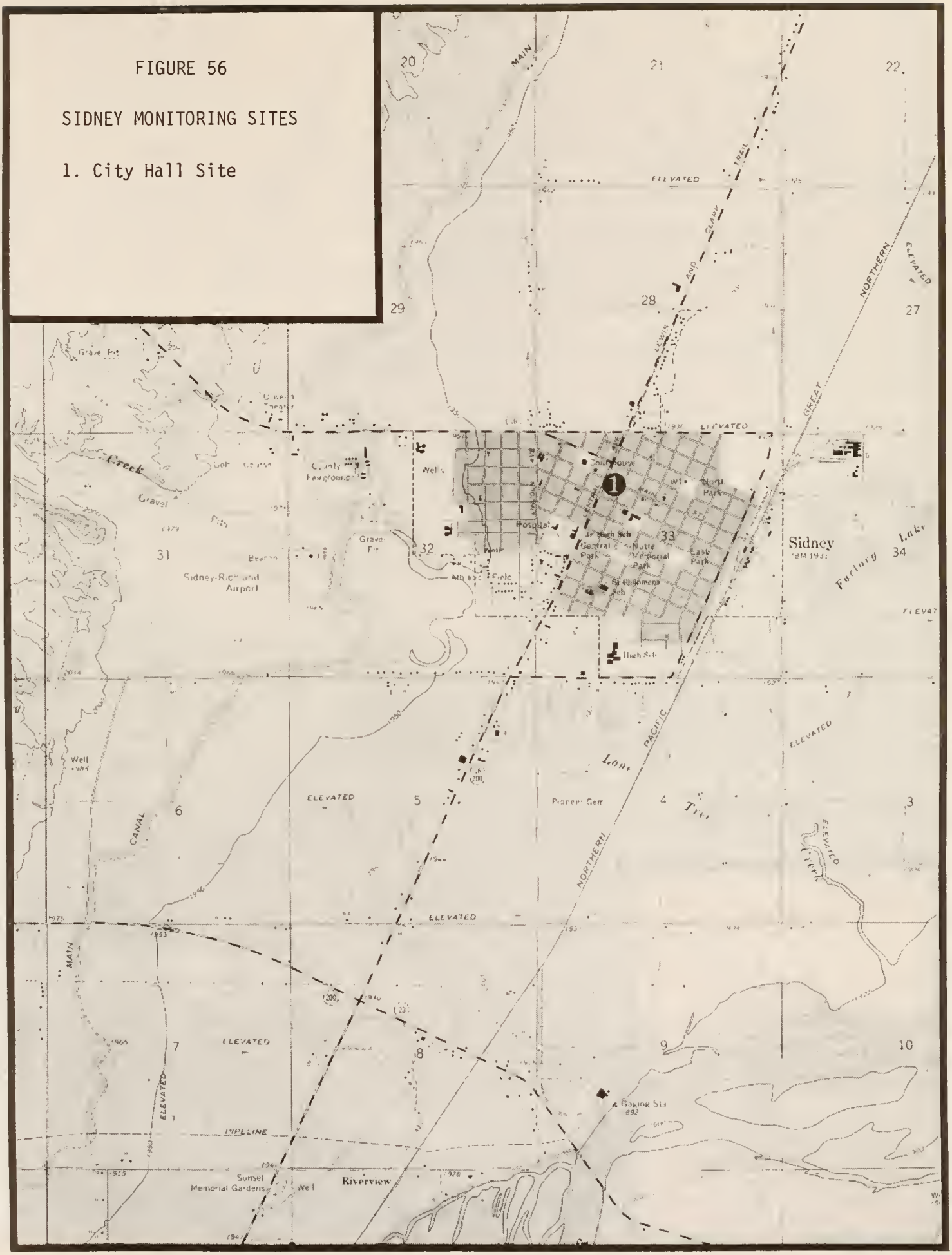
Glendive

1. Glendive is located on the Yellowstone River 220 miles downstream from Billings. The population of Glendive is about 6000 people.
2. Figure 57 is a map showing the Glendive monitoring site and Table 8 summarizes the associated TSP data.

FIGURE 56

SIDNEY MONITORING SITES

1. City Hall Site



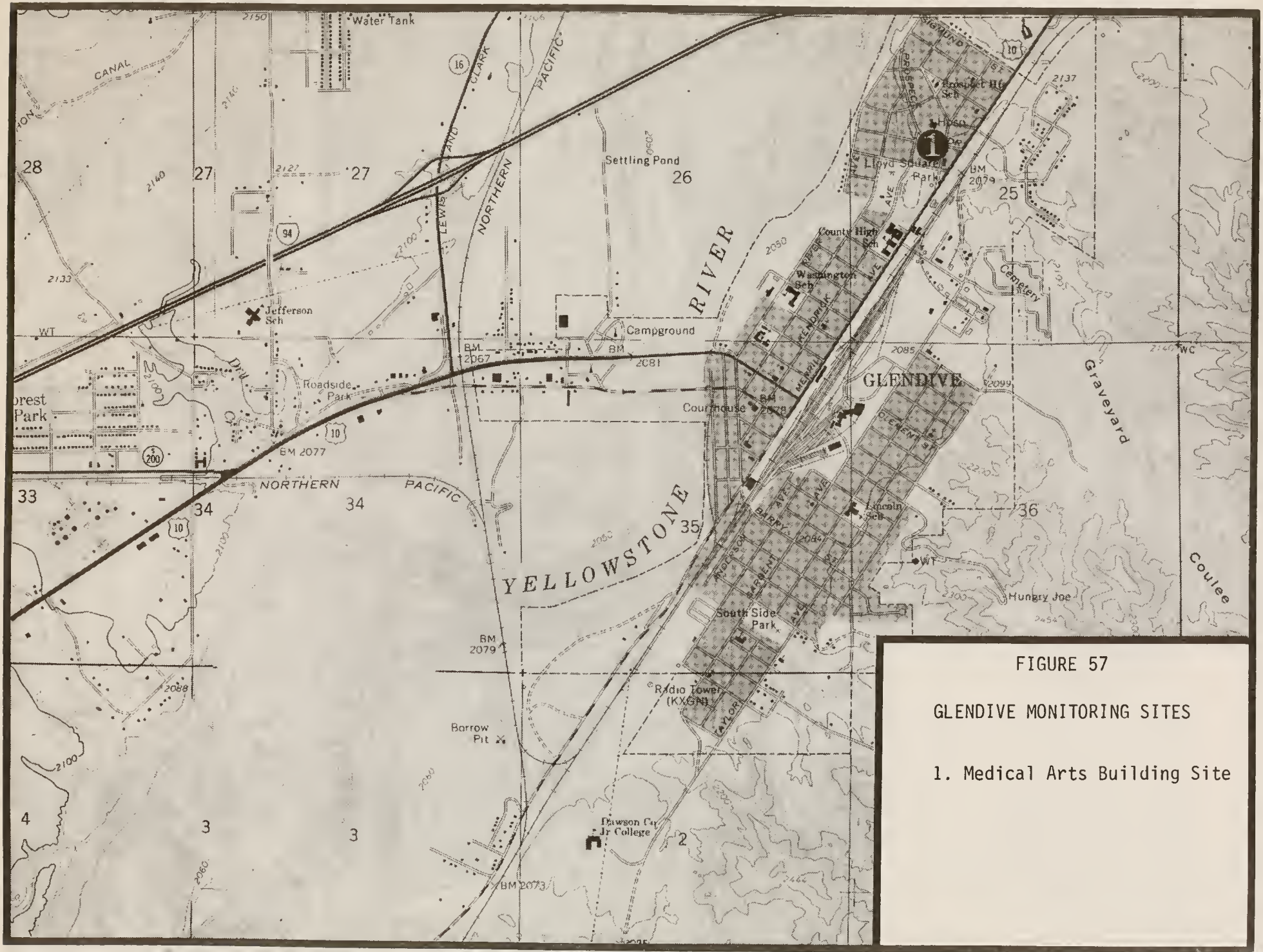


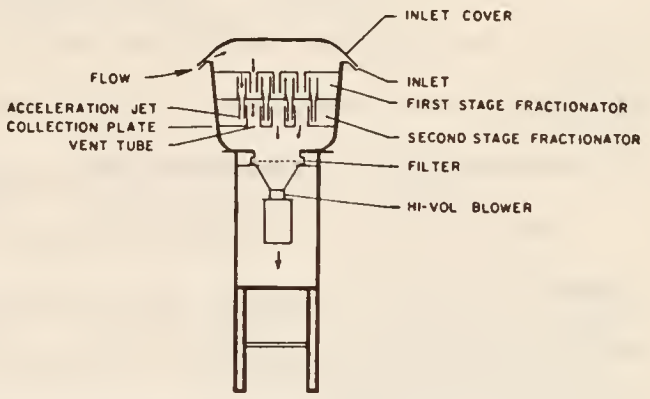
FIGURE 57

GLENDIVE MONITORING SITES

1. Medical Arts Building Site

3. In September, 1982, the Glendive site was moved from Dawson Community College to the Medical Arts Building within the city of Glendive. The department believed the new site would be more representative of TSP concentrations within the city.
4. However, over the past two years, TSP concentrations have remained very low. The geometric mean in 1984 was 29 ug/m^3 and the highest twenty-four hour reading was 72 ug/m^3.
5. In light of the low readings, the department will shut down the Medical Arts site during the summer of 1985.

PM-10



The EPA continuously reviews new research to determine if existing ambient standards are appropriate. In the case of particulates, EPA has determined that a new standard is warranted. The new standard will be based on particulate matter less than 10 microns in diameter. These smaller particles can penetrate deep into the lungs and pose a much greater health risk than the 30-40 micron particles which are included in TSP.

On March 20, 1984, the EPA published the proposed standard in the Federal Register. Final action on the proposal has been postponed three times to allow for additional comments. The latest extension is 60 days after the EPA publishes proposed guidance on how states should carry out the proposed standard revision. It is doubtful that final action will take place until mid-1986.

On May 7, 1984, and August 29, 1984, the department received memoranda via the EPA Region VIII Office from Richard Rhoads, Director of the Monitoring and Data Analysis Division at EPA in Research Triangle Park. These memoranda outlined the method by which EPA PM-10 monitors were to be distributed to the states. Montana received nineteen PM-10 samplers to be distributed to five high priority sites and two moderate priority sites.

EPA determined the priority of the Montana sites using 1980 through 1982 total suspended particulate data, a national frequency distribution for the ratios of inhalable particulate to total suspended particulate, and a methodology and computer program developed by EPA to establish the probability of a site exceeding the proposed PM-10 standards.

The department, in a parallel action, utilized the EPA methodology and computer program to develop its own site priority list. Table 25 combines the EPA results and the department results into one list. A review of the EPA and Montana results indicates some differences. The differences are caused by the following:

1. EPA used only the national frequency distribution for inhalable to total suspended particulate ratios while Montana used site specific frequency distributions.

2. EPA used only 1980-1982 TSP data while Montana used 1981-1983 data for the national frequency distribution run and the most current three years of data between 1978 and 1983 for the site specific frequency distribution runs.

TABLE 25

SITES EXHIBITING A HIGH OR MODERATE PROBABILITY OF EXCEEDING THE PROPOSED PM-10 STANDARDS - COMBINED EPA AND MONTANA RESULTS

General Area	Highest Prob. Site in Area ID#/Name	Probability 24-Hr	Annual	Proposed Location for PM-10 Monitor	Remarks
A. High Probability Sites					
Sarpy Creek, Bighorn Co.*	270060025J02 (Absaloka #2)	0.998	0.000	Near Absaloka #5	Site would be located off company property in ambient air.
Bozeman, Gallatin Co.+*	270120003F01 MSU Family Housing	0.989	0.000	East Main City Building	MSU Family Housing site shut down.
Columbia Falls, Flathead Co.+*	270270005F01 Anders Res.	1.000	0.351	Junior High School	Anders site is sited poorly.
Scobey, Daniels Co.+*	270340001F03 Border Site	1.000	0.000	Border Site	
Flathead Res., Lake Co.*	270820013K05 Ronan	0.978	0.000	Ronan	Indian jurisdiction.
Libby, Lincoln Co.+*	270900010F01 Brown Res.	0.999	0.000	Lincoln Co. Cths.	Brown site is not physically suited to handle this amount of equipment.
Missoula, Missoula Co.+*	271100024G02 Boyd Park	0.999	0.081	Boyd Park	
Fort Peck Res., Roosevelt Co.*	271340002K02 Give Out Morgan	0.965	0.000	Give Out Morgan	Indian jurisdiction.
Colstrip, Rosebud Co.+*	271360736J02 Peabody #6	1.000	0.008	MPC #3 in Colstrip	Many other high probability sites in area.
Polson, Lake Co.+	270820010F05 Mary Lozar	>0.950		Polson Saddle Shop	Indian jurisdiction.
B. Moderate Probability Sites					
Decker, Bighorn Co. +*	270060020J02 Spring Creek #3	0.592	0.000	Another site in area	But off company property.

TABLE 25, Cont.

General Area	Highest Prob. Site in Area ID#/Name	Probability 24-Hr	Annual	Proposed Location for PM-10 Monitor	Remarks
Billings, Yellowstone Co.+*	270080059F01 Central Park	0.709	0.053	City Hall	Central Park site is shut down and City Hall was responsible for the nonattainment designation.
Butte, Silver Bow Co.+*	270160005F01 Greeley School	0.884	0.013	Greeley School	
Great Falls, Cascade Co.+*	270660009G01 Fire Station	0.405	0.009	Downtown	NAMS site.
Helena, Lewis & Clark Co.+*	270720013G05 Capital Courts	0.351	0.008	Cogswell Building & Phillips Lane	To develop department expertise and to monitor in a higher concentration area.
Kalispell, Flathead Co.+*	270800304F05 Glacier Int. Airport	0.838	0.000	Universal Athletics	Glacier Int. Airport is shut down and Universal Athletics has an equal probability of nonattainment.
East Helena, Lewis & Clark Co.*	260360713002 Canal	0.840	0.003	Firehall	The canal site is shut down and the Firehall has the highest lead readings. Firehall probability = 0.263.
Thompson Falls, Sanders Co.*	271400003F05 Courthouse	0.805	0.000	Courthouse	

+Identified on EPA priority list.
*Identified on AQB priority list.

PRIORITIZATION OF SITES

The remainder of the PM-10 section uses the probability list as well as the department's specific knowledge of each monitoring site to establish a site priority list for PM-10 monitoring (Table 26).

In addition to the sites identified by the EPA's and the department's probability analyses, the list also includes several additional areas of the state which were not analyzed earlier due to insufficient or no TSP data. The department included these areas in the PM-10 Network Review based on specific knowledge about the areas.

The sites are listed from 1 through 23 with 1 being the highest priority. One staff member did not rate all the sites; therefore, the average rating is based on either eight or nine individual ratings. The final column displays the range of ratings between individual staff members. Since four sites were added to the list during the discussion period, staff members did not usually use numbers 20 through 23, but instead placed the sites in their original scheme by using a duplicate number.

The following narrative identifies the various reasons why certain sites rated high and others were given a low priority.

Libby

The TSP data from the sampler at the Brown residence was used in both the EPA and Montana probability analyses. The department, however, decided to locate the PM-10 site at the Lincoln County Courthouse for several reasons: (1) the Courthouse site complies with all siting criteria while the Brown residence does not meet all the "shoulds;" (2) the 1983 TSP concentrations correlated very well ($r = .880$) between the two sites and the mean concentrations were within 0.7 ug/m^3 of each other; and (3) the Brown residence

TABLE 26

PRIORITIZED LIST OF PROPOSED PM-10 AIR MONITORING SITES

Geographic Area	Proposed Site	Average	Range
1. Libby+*	Lincoln County Courthouse	1.89	1-6
2. Missoula+*	Boyd Park	2.50	1-7
3. Bozeman+*	East Main City Building	5.30	2-9
4. Butte+*	Greeley School	5.67	2-15
5. Helena+*	Phillips Lane	5.89	3-12
6. Columbia Falls+*	Junior High School	6.25	2-10
7. Kalispell+*	Universal Athletics	8.67	5-11
8. Billings+*	City Hall	8.78	3-20
9. Thompson Falls*	Sanders County Courthouse	8.89	3-14
10. Western Montana background site#	Ovando	9.86	5-15
11. East Helena*	Firehall	10.11	8-14
12. Hamilton#	Ravalli County Courthouse	10.14	7-12
13. Ronan*	City Park	10.63	3-15
14. Great Falls+*	Downtown	10.75	4-16
15. Polson+	Saddle Shop	11.00	2-18
16. Eureka#	Lincoln Elec. Coop.	11.78	10-16
17. Colstrip+*	City Park - MPC #3	13.38	4-19
18. Ramsay#	Tierney Res.	13.68	7-22
19. Eastern Montana background#	Winnett	15.60	10-19
20. Decker+*	New site	16.25	12-18
21. Sarpy Creek*	New site	16.37	14-19
22. Fort Peck*	Give Out Morgan	17.38	15-19
23. Scobey+*	Border	18.00	15-20

+Identified on EPA priority list.
*Identified on department priority list.
#Additional sites added by the department.

is not physically capable of handling more than one sampler. During 1984, the geometric means at the two sites were again within 4 percent of each other.

The department prioritized the Libby area number 1 because of the high probability that the site would exceed the proposed PM-10 standards and because the suspected particulate sources include sources of fine particulate such as residential wood burning, wood products industries (sawmill and plywood plant), and forest slash burning. Some staff members rated Libby as low as number 6 because of the low population base (2700 pop.) and the fact that re-entrained road dust may also be a major contributor.

The department installed a PM-10 monitor at the Lincoln County Courthouse during May, 1985.

Missoula

Several Missoula sites exhibited high probabilities of exceeding the proposed PM-10 standards, with the Boyd Park site showing the highest. The Boyd Park site meets all siting criteria. The Missoula County Health Department has purchased and installed PM-10 monitors at Boyd Park as well as Rose Park.

The department staff ranked Missoula number 2 on the priority list due to the high probability that the area will exceed the proposed PM-10 standards and since the high wintertime TSP readings are primarily fine particulate from residential wood burning. The large population base (60,000 pop.) in the Missoula valley was also important.

Missoula has exchanged one 15 micron head for an EPA PM-10 inlet and acquired an additional PM-10 sampler from the department. These two PM-10 samplers have been installed at Rose and Boyd Parks to allow daily sampling at both sites and to assist in the determination of whether to move the episode monitoring responsibility from Rose Park to Boyd Park. The County is also

trying to exchange another PM-15 inlet for a PM-10 sampling head to be installed at either the Meadow Hills School or Health Department sites.

Bozeman

The discontinued MSU Family Housing site was responsible for listing Bozeman as an area with a high probability of exceeding the proposed PM-10 standards. The newer East Main City Building has actually recorded higher annual averages and equally high individual readings. Therefore, the department installed a PM-10 monitor at the East Main City Building during July, 1985.

The major sources of particulates in the Bozeman area are residential wood burning, re-entrained road dust, slash burning, and agricultural burning.

Butte

The Greeley School site exhibited a high probability of exceeding the proposed PM-10 standard. The department installed a PM-10 monitor at the Greeley School during June, 1985.

Most department staff members ranked Butte quite high because of the large population and the fact that residential wood burning appears to be a substantial problem. Others rated the area much lower despite these facts. These individuals considered the fact that Butte has a decreasing population and that TSP concentrations have decreased since the curtailment of the Anaconda Company Berkeley Pit copper mine in 1981. In fact, the geometric means at the Greeley School were below federal secondary standards in both 1982 and 1983. Although concentrations are lower, wintertime readings are still quite high and probably are due to residential wood burning.

Helena

Despite only receiving a moderate probability of exceeding the proposed PM-10 standards, the department staff ranked this area number 5. The Capital Courts site was responsible for the moderate probability rating; however, the department decided to locate one site out in the valley and the other at the Cogswell Building. During temperature inversions, the cold air flows to the center of the valley carrying the smoke with it. The department suspects that fine particulate concentrations are higher at the valley locations. The department selected a location on Phillips Lane for PM-10 monitoring. On the other hand, the Cogswell Building site will provide the department staff with hands-on experience assisting in operating an efficient PM-10 network. The department installed collocated PM-10 monitors at the Cogswell Building in May, 1985, and a single PM-10 sampler at the Phillips Lane site in August, 1985.

Most staff members ranked the Helena area fairly high due to population growth (currently 35,000 in the valley area) and an increasing wood smoke problem. Some members ranked the area as low as 12 because they believed the wood smoke problem, although bad, is worse in other areas.

Columbia Falls

The Anders Residence site exhibited a high probability of exceeding the proposed PM-10 standards. Although the Anders site technically meets siting criteria, it is not a very good site. It is located approximately 100 feet from the main street of town and is located in a valley which is actually below the road surface. There is also a chimney from a wood stove in close proximity. The department has continued to operate this site since it was responsible for the area's nonattainment designation and is important for tracking the effectiveness of the control strategies. However, the department installed the

PM-10 monitor at the Junior High School during May, 1985. This location easily meets all siting criteria.

Columbia Falls received a fairly high overall ranking (#6). Some staff members ranked this site as high as 2 because Columbia Falls has historically had some of the highest TSP concentrations in Montana (1981 - annual average = 108 ug/m^3, highest individual reading = 494 ug/m^3). These staff members also considered the large amount of residential wood burning occurring in the area as well as the concentration of wood product industries.

Other staff members rated the area lower because of the relatively low population (3100 pop.) and since TSP concentrations have been drastically reduced in recent years. In 1983, the annual average was 69 ug/m^3 and the highest individual concentration was 274 ug/m^3. This reduction in ambient concentrations was probably caused by the 1982-1984 reconstruction of Highway 40 through Columbia Falls and Nucleus Avenue. Both projects were identified in the SIP as control strategies to reduce fugitive dust and subsequently TSP levels. It appears that these projects have been effective. Therefore, the present particulate levels are probably fine particulate largely originating from residential wood burning, wood product industries, and forest slash burning.

Kalispell

The Kalispell area was ranked number 7 by the department staff despite the fact that the TSP data from the Universal Athletics site only indicated a moderate probability of exceeding the proposed PM-10 standards. The department installed a PM-10 monitor in Kalispell at the Universal Athletics site during May, 1985.

The department staff cited several reasons for ranking the Kalispell area high, including: the relatively large population base (12,000 pop.),

widespread use of residential wood burning devices, and the relatively high TSP concentrations. Some staff members rated the area lower due to an analysis contained in the 1983 Network Review which seemed to indicate a significant portion of the catch at the Universal Athletics site is re-entrained road dust.

Billings

The department and the EPA analyses determined that the city of Billings had a moderate probability of exceeding the proposed PM-10 standards based on data from the closed Central Park site. When PM-10 monitoring is initiated in Billings, the County will install the sampler at the City Hall site.

Although the department staff rated the Billings area number 8 on the priority list, there was a wide range of opinion (3rd to 20th). Some ranked the area very high due to the large population of the area (70,000 pop.) while others rated it lower due to moderate TSP levels which, according to the analyses contained in the 1981 and 1983 Network Reviews, consist of fugitive dust from dusty streets and commercial/industrial activity.

Thompson Falls

The Thompson Falls TSP site was established in January of 1983 and therefore was not included in the EPA analysis. However, the Montana analysis using 1983 TSP data indicated a moderate probability (P = 0.805) that Thompson Falls will exceed the proposed twenty-four hour PM-10 standard. In addition, the 1984 annual arithmetic mean for TSP at the Thompson Falls site was actually 50 percent higher than 1983. Three twenty-four hour concentrations were over 360 ug/m^3. No doubt if the analysis were done on 1984 data, the probability would be even higher.

The Thompson Falls area was ranked number 9 because of the high TSP values and suspected impacts from residential wood burning, the wood products industry and slash burning. The area would probably have been rated even higher had more TSP data been available. The small population of the area, however, tended to lower the rating.

The department installed a PM-10 monitor at the Sanders County Courthouse during May, 1985.

Western Montana Background Site

If and when a PM-10 ambient standard is adopted, PM-10 increments may also be adopted. In order to protect the ambient standards and increments, it will be important to know what background PM-10 concentrations are. In May, 1985, the department initiated background PM-10 monitoring at the existing TSP background site near Ovando, Montana.

The staff felt this site was necessary to prove one of two opposite theories on the particle size distribution of Montana background particulates: (1) background particulates are fine particulates carried by regional weather patterns, or (2) background particulates are large fugitive particles from local sources such as agricultural fields.

East Helena

The department ranked the East Helena area near the middle of the priority list primarily due to the department's and EPA's analyses which showed a moderate probability of exceeding the proposed PM-10 standards. Particulate data gathered over the last few years by several devices (high volume samplers, dichotomous samplers, and low volume samplers) indicate that much of the particulate is in the larger size ranges, especially the lead. A

lead smelter and paint pigment plant are located at East Helena. Recent increases in TSP levels and the high concentrations of heavy metals in the East Helena air probably resulted in the area being rated higher than it normally would have been.

Hamilton

The Hamilton area was not included in either the department's or EPA's probability analyses since a site was not established there until the middle of 1983. The department staff assigned the Hamilton area a priority which is near the center of the priority list. Although residential wood burning is most likely the predominant source of particulates at the site, TSP concentrations are generally lower than other western Montana valleys. Therefore, the department was reluctant to rank the Ravalli County Courthouse higher.

Ronan

The Ronan City Park site was given a high probability of exceeding the proposed PM-10 standards due to the department's analysis. The area was ranked near the middle of the list by department staff because TSP readings were high but not as high as other western Montana areas. The primary emissions sources involved are residential wood burning and re-entrained road dust.

Great Falls

The department staff prioritized the Great Falls area near the middle of the site list because of relatively low TSP concentrations but a high population base. The probability of exceeding the PM-10 standards was projected as moderate by both EPA and Montana. Re-entrained road dust and tailpipe

emissions are important sources of particulates as well as residential wood burning. When the PM-10 site is established in Great Falls, it will be at the Downtown NAMS site.

Polson

Polson was identified through the EPA's analysis as having a high probability of exceeding the twenty-four hour PM-10 standard. The TSP data from the now shutdown Mary Lozar residence was used in the EPA analysis. This sampler was located in a rural area approximately two miles from Polson and was probably recording an occasionally high concentration due to road construction at the intersection of Highways 93 and 35 and/or agricultural activity. The Flathead tribe has established a new site in Polson at the Polson Saddle Shop and the PM-10 monitor is located there.

The department staff generally rated Polson in the middle of the list because of the probable cause of the high readings at the Mary Lozar site. On the other hand, recent data from the Saddle Shop sampler indicates TSP concentrations near state and federal standards. Particulate sources which are most likely affecting the Saddle Shop site include re-entrained road dust and residential wood burning.

Eureka

The Eureka area was not addressed in either the Montana or EPA probability analyses since TSP data was not available. The department established a high volume sampler at the Lincoln Electric Coop. site during the late spring of 1984. After seven months of operation, TSP values were very similar to Libby with a geometric mean of 64 ug/m^3 and two twenty-four hour values over 260 ug/m^3.

The department staff ranked the Eureka area moderately low mainly due to a lack of information. It is likely that as more data is collected the area will require PM-10 monitoring. On the other hand, the population of Eureka is only 1100 people.

Colstrip

Although the Montana and EPA analyses indicated that the Colstrip area has a high probability of exceeding the proposed PM-10 standard, the department staff prioritized the area quite low. There are several reasons for the low ranking including: (1) all of the sites exhibiting a high probability of exceeding the proposed PM-10 standards are on company property and not ambient samplers, (2) the high probability predictions resulted from occasional high twenty-four hour concentrations due to windblown dust from nearby coal mines and agricultural activity, and (3) these particles are relatively large.

If the department were to establish a PM-10 site in the area it would be at the Montana Power Site #3 within the community of Colstrip. This site is an ambient site with good population exposure and could be operated by the department or the Montana Power Company.

Ramsay

The Ramsay area was added to the priority list because of the nearby Stauffer Chemical Company elemental phosphorus plant. This plant emits large volumes of phosphorus pentoxide and fluoride particulates which have small particle diameters and are very visible. Despite these facts the staff ranked the Ramsay area low because many years of ambient data have shown relatively low concentrations of TSP (40-50 ug/m^3).

Eastern Montana Background

The department considered the same information it considered for the western Montana background site but ranked eastern Montana much lower because of the relatively few particulate problems in eastern Montana. Due to funding problems, the department does not intend to establish an eastern Montana background site for either TSP or PM-10.

Sarpy Creek and Decker

Both of these areas were ranked very low by department staff despite having high and moderate probabilities of exceeding the proposed PM-10 standards. All of the sites used in the Montana and EPA analyses were on company property and not ambient sites. In addition, the particulates involved are probably large diameter particles blowing from agricultural fields and coal mines.

Fort Peck and Scobey

Both these areas are in northeastern Montana and were rated very low by department staff. Detailed investigations over the past four years have shown that the occasional high TSP concentrations in these areas are caused by dust storms off agricultural fields. Due to the large particles involved, PM-10 sampling seems unnecessary.

ECONOMIC CONSIDERATIONS

Even a limited PM-10 monitoring program will result in substantial increases in both capital cost and operating cost over the present TSP network. The capital costs are involved with remodeling site facilities to handle additional samplers and, if an extensive program is embarked upon, the department will need to modify its dichotomous samplers with PM-10 sample

heads or purchase new equipment. The increased operating costs are largely the result of the increased sampling frequencies outlined in the proposed PM-10 standards and maintenance costs associated with PM-10 samplers. Specific areas where operating costs will increase are laboratory filter analysis, electricity, personnel, repairs and supplies.

A memorandum from Bob Raisch to Hal Robbins entitled "The Proposed PM-10 Standard and Associated Monitoring Costs" outlines these costs in greater detail. The department has relied heavily on this document to determine what PM-10 monitoring the agency can financially afford. In order to stay within fiscal restraints, the department has proposed and substantially installed a PM-10 network which incorporates sampling frequencies much less intense than those proposed in the March 20, 1984 Federal Register. The establishment of the PM-10 network will result in reductions in the present TSP, metals and sulfation plate network. The department believes the sample frequencies can be increased at a later date if and when the proposed federal regulations become final. This will no doubt require further cuts in the existing Montana monitoring network.

Table 27 describes the PM-10 monitoring network that the department intends to operate. The department has already installed many of the PM-10 monitors and hopes to have the entire network operating by August 30, 1985.

TABLE 27

PROPOSED PM-10 NETWORK

Area	Site	Sampling Frequency	Number of Samplers[1]	TSP	Increased Capital Cost[3]	Increased Operating Costs
Libby	Lincoln Co. Courthouse	every sixth day	2 (1 coloc)	yes (coloc)	$ 70.00	$ 1,305.00[4]
Missoula	Rose Park	daily	2	yes	no DHES cost	no DHES cost
	Boyd Park	daily	2	yes	no DHES cost	no DHES cost
	Meadow Hill School	every third day	2	yes	no DHES cost	no DHES cost
Bozeman	East Main City Bldg.	every sixth day	1	yes	30.00	353.00[4,5]
Butte	Greeley School	every sixth day	1	yes	30.00	653.00[4]
Helena	Cogswell Building	every sixth day	2 (1 coloc)	yes	70.00	705.00[4,5]
Helena	Phillips Lane[2]	every sixth day	1	no	200.00	80.00[4,5]
Columbia Falls	Junior High School[2]	every sixth day	1	yes	200.00	1,426.00[7]
Kalispell	Universal Athletics	every sixth day	1	yes	30.00	353.00[4,5]
Billings	City Hall	every sixth day	1	yes	30.00	413.00[5]
Thompson Falls	Sanders Co. Courthouse	every sixth day	1	yes	30.00	353.00[4,5]
Western Montana Bkgd.	Ovando-Smith	every sixth day	1	yes	30.00	713.00
E.Helena	Firehall	every sixth day	1	yes	100.00	353.00[4,5]
Hamilton	Ravalli Co. Courthouse	every sixth day	1	no	10.00	80.00[4,5,6]
Ronan	None (use Polson)					
Great Falls	Downtown	every sixth day	1	yes	30.00	353.00[4,5]
Polson	Saddle Shop	every sixth day	1	yes	no DHES cost	no DHES cost
					$ 860.00	$6,427.00

GRAND TOTAL = $ 7,287.00

NOTES:

1 This siting arrangement will leave two samplers for special studies.
2 New site.
3 Site modification costs.
4 Free electricity.
5 Free manpower.
6 Savings due to not running TSP taken into account.
7 Cost includes operating TSP at this new site.

Lead

The primary sources of ambient lead are automobile tailpipe emissions and the metal mining and processing industry. Since Montana does not have any large cities, automobiles are a relatively minor source of lead. On the other hand, the ASARCO lead smelter and the American Chemet plant in East Helena are major lead emitters. Tailings piles and waste dumps from abandoned mines and mills and the old Anaconda smelter are also potential sources of lead.

Anaconda

1. During July of 1980, a labor strike closed the Anaconda smelter. In September, management announced the permanent closure of the plant. The department has monitored lead at the Lincoln School and Highway Junction sites since the sites were established.
2. During 1984 lead concentrations at the Lincoln School site remained quite low. The highest 1984 quarterly average concentration occurred during the first quarter and registered 0.035 ug/m^3. The highest twenty-four hour value was 0.13 ug/m^3. These concentrations are less than 3 percent of the lead ambient standard.
3. The department stopped analyzing the Lincoln School filters for lead in May, 1985. The department could not afford the laboratory costs and the concentrations were just barely above background.

4. The Highway Junction site was re-established during July, 1984. The primary objective was to gather arsenic data during the demolition of the Anaconda smelter. Local residents complained that high winds were blowing arsenic dust from the smelter during demolition.

5. During the last two quarters of 1984, the quarterly means for lead at the Highway Junction site were 0.029 ug/m^3 and 0.145 ug/m^3. These concentrations are less than 10 percent of the ambient lead standard. Due to the low readings and high laboratory costs, the department will no longer analyze the Highway Junction filters for lead.

East Helena

1. The department and the ASARCO lead smelter are presently operating a lead sampling network in the East Helena area as part of the Montana SIP requirements. Table 28 describes the 1984 network, while Figure 34 shows the geographical locations of the sites. The present network is a condensed version of the more elaborate network operated during 1981.

TABLE 28

EAST HELENA LEAD MONITORING NETWORK

Site	Location	Parameters	Equipment	Responsible Organization (Field/Laboratory)
Hastie residence	212 Pacific, .2 miles north of smelter slag pile	TSP Pb,Cu,Zn,As,Cd Elemental	Hi-vol Hi-vol Lo-vol	ASARCO/DHES ASARCO/DHES ASARCO/ASARCO
Hadfield	Hadfield TV Repair, Main Street, .2 miles north of smelter	TSP Pb,Cu,Zn,As,Cd Elemental	Hi-vol Hi-vol Lo-vol	ASARCO/DHES ASARCO/DHES ASARCO/ASARCO
Firehall	East Helena Firehall, Pacific Street, .2 miles north of smelter	TSP Pb,Cu,Zn,As,Cd Elemental	Hi-vol Hi-vol Lo-vol	ASARCO/DHES ASARCO/DHES ASARCO/ASARCO
South	Kleffner Field, .5 miles SSE of smelter	TSP Pb,Cu,Zn,As,Cd	Hi-vol Hi-vol	DHES/DHES DHES/DHES
Dartman Field	North edge of East Helena, .5 miles north of smelter	TSP Pb,Cu,Zn,As,Cd	Hi-vol Hi-vol	DHES/DHES DHES/DHES

2. The 1981 network was described in the 1982 Network Review and was designed to determine the geographical extent of high ambient lead concentrations. During 1984, the department, with the assistance of ASARCO, continued to operate all the lead monitors which exhibited violations of the federal lead standard. These sites included the South, Hastie, Hadfield, Dartman Field and Firehall sites. The department also performed lead analyses on filters from the Montana City site because it is in the vicinity of East Helena. The Hadfield, Hastie and Firehall sites are operated on a one-in-three day cycle by ASARCO, while the South, Dartman Field, and Montana City samplers are operated by the department on the standard six-day cycle.

3. The ASARCO sites are equipped with low volume samplers utilizing teflon filters. These filters are sent to a private laboratory for chemical analysis by X-ray fluorescence and the data are used to perform a chemical mass balance (CMB). The results of the CMB analysis are used to track the lead control strategies on a source specific basis.

4. Table 29 summarizes the 1984 lead data for the East Helena area. The only sites which did not violate the state and federal ambient standards during 1984 were the South and Montana City sites. The data from the Firehall, Hadfield and Hastie sites exceeded the standard during every quarter of 1984. The Dartman Field site exceeded the standards during every quarter except the second quarter.

5. The department performed linear regression analyses to compare lead data between sites. The department also performed linear regression analyses to compare lead data at each site with TSP and other trace metal data from the same site. The results of these analyses are provided and discussed in detail in the TSP section of this report.

TABLE 29

EAST HELENA LEAD DATA FOR 1984
(ug/m^3)

Site	1st Quarter Mean	1st Quarter Max.	2nd Quarter Mean	2nd Quarter Max.	3rd Quarter Mean	3rd Quarter Max.	4th Quarter Mean	4th Quarter Max.
Hastie	3.26	10.25	1.71	5.66	2.66	11.09	3.86	12.89
South	1.47	5.53	1.21	3.85	0.98	2.18	1.43	7.11
Hadfield	4.12	12.88	1.82	8.30	3.38	11.13	4.63	17.73
Dartman Field	3.19	10.96	1.26	3.70	3.10	7.85	3.23	7.67
Firehall	5.77	17.12	2.74	9.10	5.61	16.58	6.82	19.27
Montana City	0.06	0.13	0.01	0.03	0.09	0.39	0.22	0.76

6. During 1981, a detailed chemical mass balance analysis was performed by NEA, Inc. of Beaverton, Oregon, to determine the source contributions at most of the sampling locations. The analysis indicated that re-entrained road dust and soil, fugitive ore concentrates, zinc oxide material, and blast furnace upsets were the primary lead sources. ASARCO repeated the original CMB study during 1983 and 1984. The second and ongoing study was intended to refine the data from the original study. Although the final report is still in a draft stage, the results indicate that ore handling, the sinter building, and the American Chemet plant are significant sources.

7. The Hastie residence sampler has monitored ambient lead concentrations since 1977. It is located at 212 Pacific Street, directly across Highway 12 from the ASARCO smelter slag pile. The site has exceeded the 1.5 ug/m^3 quarterly standard over its entire history. In 1984, the highest quarterly mean was recorded during the third quarter and registered 5.66 ug/m^3.

8. In an effort to save money, the department plans to discontinue TSP and lead monitoring at the Hastie site during the summer of 1985. The department will leave the equipment in place if ASARCO wishes to take over the laboratory analysis, site maintenance, and utilities. The site usually records lower lead values than the nearby Firehall and Hadfield sites and the lead data correlates fairly well with the Firehall site. The department believes that the Firehall and Hadfield sites adequately monitor this part of East Helena. In addition, the Hastie site is being overgrown by trees.

9. The Hadfield monitor is located 0.2 mile north of the ASARCO smelter and the American Chemet plant. It is situated south of Main Street and about five blocks west of the Hastie site. The lead concentrations at the Hadfield site exceeded the ambient lead standard during all four quarters of 1984.

10. The department will perform lead analyses on the Hadfield high volume filters indefinitely. The department considers the site essential for tracking the lead and TSP control strategies, especially since the Hadfield site recorded the highest TSP readings and second highest lead reading of any of the East Helena sites.

11. The Dartman Field site is located in a field on the north edge of East Helena. It is approximately 0.5 mile north of the ASARCO smelter. Although this site is located on the opposite side of town from the smelter, it still records high lead concentrations. In 1984, lead data exceeded the standards for every quarter except the second quarter. The highest quarterly reading was observed during the third quarter at 3.70 ug/m^3.

12. The department intends to continue to operate the Dartman Field site to track the East Helena lead SIP. The department believes that this is an important site, especially because it is located farther from the smelter complex and the department suspects that emissions from the main stack may be impacting the sampler.

13. The Firehall site is located on Pacific Street across Highway 12 from the ASARCO smelter and the American Chemet plant. The Firehall consistently registers the highest lead readings in the state. During 1984, the lead concentrations exceeded the ambient standards during all four quarters. The highest quarterly mean was 6.82 ug/m^3. This value is 4.5 times higher than the standard.

14. The department, with the assistance of ASARCO, will continue to operate the Firehall site. The Firehall site is a key East Helena site, since the lead control strategies are based on this data.

15. The South site is located 0.5 mile south-southeast of the ASARCO smelter complex. During the original lead monitoring effort it was the only site which was not north of the smelter that showed ambient lead violations. The sampler is located in a field and surrounded by agricultural and pasture land. Since 1982, the lead concentrations at the South site have been in compliance with the lead standards. In 1984, the highest quarterly average was 1.47 ug/m^3, and occurred during the first quarter.

16. The department believes that the South site is impacted by a different set of lead sources than the other East Helena sites. The most likely source is lead-contaminated soils and ore concentrates resuspended by the wind. The South site is located downwind of the smelter complex in relation to the stronger west and northwest winds. The other East Helena sites are influenced more by process emissions from the smelter and the American

Chemet plant. The results of the linear regressions discussed in the East Helena TSP section also indicate that the South site is influenced by different emission sources.

17. Despite the possibility that the South site is monitoring different emission sources, the department shut down the site in April, 1985. The primary reason for terminating the site was to save money on laboratory charges. The department also considered the site unnecessary because the control strategies necessary to achieve compliance at the Firehall will also result in compliance at the South site with a wide margin of safety.

Arsenic

Arsenic is primarily emitted by smelters and as fugitive dust from mining and smelting activity. In Montana, the ASARCO lead smelter and the shutdown Anaconda copper smelter are the major sources of arsenic. Waste materials from abandoned mines and milling operations can also be sources of windblown arsenic.

Anaconda

1. The department operates the Highway Junction site near Anaconda to monitor arsenic levels during the demolition of the old Anaconda copper smelter. The department received numerous complaints from local residents concerning windblown arsenic-laden dust. As a result, the department runs an additional high volume sampler at the Highway Junction site and the Mill Creek site to monitor arsenic levels on windy days. These samplers are only started when the local operator notices tailings or dust from the demolition activity being whipped into the air. In addition, ARCO analyzes the filters from their samplers at the Lincoln School, Mill Creek and Johnson Curve sites for arsenic.
2. The department installed the high volume sampler at the Highway Junction site in July, 1984. The highest twenty-four hour arsenic concentration during 1984 was 2.01 ug/m^3. The arithmetic mean for the last seven months

of 1984 was 0.17 ug/m^3. Although these concentrations are not alarming, they are definitely elevated and continued monitoring is warranted. Neither Montana nor the federal government have promulgated ambient standards for arsenic.

3. The department intends to continue arsenic analysis on a routine basis at the Highway Junction site. The department will also sample for arsenic at the Lincoln School, Mill Creek and Highway Junction sites on windy days.

East Helena

1. Although the primary purpose of the East Helena high volume sampling network is to monitor TSP and lead, the department also analyzed the filters for other trace metals including arsenic. Table 30 summarizes the arsenic data for East Helena. The highest arsenic levels were recorded at the Firehall site. The annual arithmetic mean was 0.416 ug/m^3 and the highest twenty-four hour value was 1.657 ug/m^3.
2. The department used linear regression analyses to compare arsenic data among the East Helena sites. Linear regression analyses were also performed to compare arsenic concentrations with TSP and other trace metals at the same site. The results are discussed in the East Helena section on

TABLE 30

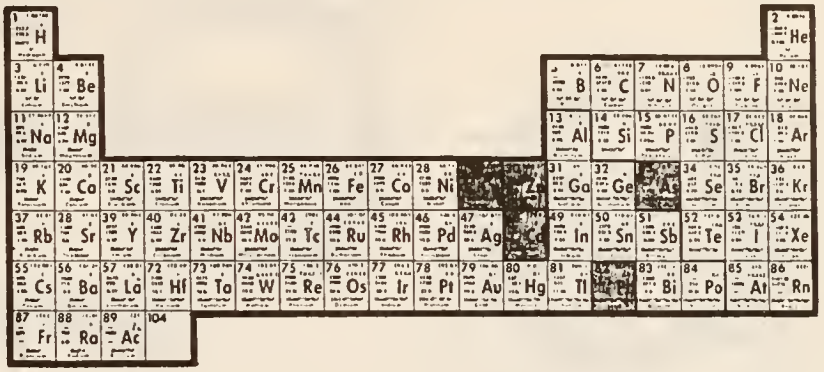
1984 ARSENIC DATA FOR EAST HELENA SITES
(ug/m^3)

Site	No. of Observations	Arith. Mean	Maximum
Hastie	107	0.195	0.820
Firehall	115	0.416	1.657
South	60	0.097	0.233
Dartman Field	59	0.206	0.934
Hadfield	116	0.261	1.359

TSP. The analyses indicated that arsenic and lead data correlate well and therefore it is not surprising that the Firehall site also recorded the highest lead values.

3. As a cost-cutting measure, the department stopped analyzing the East Helena filters for arsenic and other trace metals with the exception of lead in May, 1985. The department does not intend to do any future arsenic monitoring in East Helena. However, the department will review the trace metal data being obtained by ASARCO from low volume sampler filters.

Trace Metal



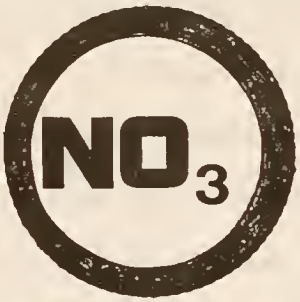
In 1984, the department analyzed high volume sampler filters for trace metals in Anaconda, East Helena and Thompson Falls. The department analyzed the Thompson Falls filters for trace metals because the Sanders County Courthouse is the nearest monitoring site to the U.S. Antimony plant located twelve miles up Prospect Creek. The data is summarized in Table 31. In May, 1985, the department stopped analyzing for most trace metals due to high laboratory costs. The department is still sampling for lead at all the operating East Helena sites and arsenic at the Anaconda sites. The department will also continue to analyze for copper and zinc at the East Helena Firehall site. All other trace metal analysis has been terminated.

TABLE 31

1984 TRACE METAL DATA
(Arithmetic Means in ug/m^3)

Site	City	Antimony	Cadmium	Chromium	Copper	Iron	Zinc
Sanders Co. Crths.	Thompson Falls	0.012	0.000	0.000	0.011	1.390	0.005
Hastie	East Helena		0.117		1.640		1.976
Firehall	East Helena		0.250		7.250		3.021
South	East Helena		0.065		0.413		0.451
Hadfield	East Helena		0.193		3.903		8.414
Dartman Field	East Helena		0.137		1.915		1.782

Sulfates & Nitrates



The department analyzed high volume sampler filters for sulfates at eight locations throughout Montana including two sites in Glacier National Park. The Glacier National Park sites are operated by the National Park Service while the Health Department performs the repairs, calibrations, and filter analyses. Missoula County performs similar analyses on the Rose Park filters and the two Champion International sites.

Sulfates are usually formed by the oxidation of sulfur dioxide and other sulfur compounds in the atmosphere. Therefore, sulfates serve as an indicator of gaseous sulfur compounds.

The federal land managers who are in charge of many of the pristine Class I areas in Montana are expressing increasing concerns about the possible effects from visibility degradation and acid deposition. Since airborne sulfates can significantly reduce visibility and lower the pH of wet and dry deposition, the federal land managers frequently advocate additional sulfate monitoring in or near Class I areas.

The department is also interested in acid deposition and visibility as witnessed by our proposed site near the Gates of the Mountains Wilderness.

However, sulfate analysis is very expensive and the department's air program is actually experiencing budget cutbacks. In addition, the department either operates or assists in the operation of only four sites near any of Montana's Class I areas and sulfates are being monitored at two of those sites. The department cannot justify establishing additional remote monitoring sites when many areas of Montana are actually exceeding health related ambient standards.

Table 32 lists the sulfate data for all the Montana sites. The department stopped analyzing for sulfates at all three Scobey sites and the Kalispell Courthouse East site in January, 1984. As a cost saving measure, the department terminated sulfate analysis at the Kalispell Universal Athletics and Sidney sites on December 31, 1985. The department will continue to analyze the Glacier National Park high volume filters for sulfates and Missoula County personnel will also analyze for sulfates at the Rose Park site and the two Champion sites. The Missoula sites are designed to track sulfur emissions from the Champion International paper mill eight miles west of Missoula.

The department also analyzed high volume sampler filters for nitrates from eight sites throughout Montana including the two Glacier National Park sites. The results are shown in Table 32.

Nitrates are formed by the oxidation of nitrogen oxides in the atmosphere. They generally are rough indicators of emissions from fossil fuel combustion sources.

The department intends to eliminate all nitrate analyses during 1985, except for the Glacier National Park sites. The primary reason is to cut monitoring costs.

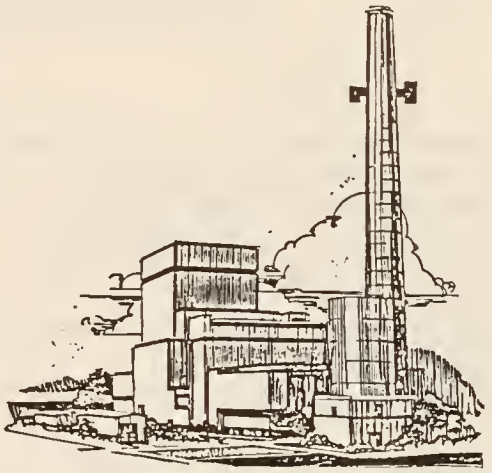
TABLE 32

SUMMARY OF 1984 SULFATE AND NITRATE DATA

Site	Sulfates		Nitrates	
	24-hr. Max.	Mean[1]	24-hr. Max.	Mean[1]
Scobey Border	2.2	2.2 (1)	0.5	0.5 (1)
Scobey Richardson	2.3	2.3 (1)	0.5	0.5 (1)
Scobey Hanrahan	3.2	3.2 (1)	0.5	0.5 (1)
Sidney Downtown	13.4	4.9 (30)	3.8	0.9 (23)
Glacier National Park F.W.S.	3.8	1.2 (48)	1.8	0.4 (48)
GNP St. Mary's	7.3	1.1 (45)	3.2	0.3 (45)
Kalispell Universal Athletics	4.7	2.6 (40)	3.1	0.8 (40)
Kalispell Courthouse East	4.1	4.1 (1)	5.2	5.2 (1)
Champion #1	11.0	3.2 (113)		
Champion #2	12.2	2.9 (119)		
Missoula Rose Park	10.3	3.7 (78)		

1. Parentheses denote the number of samples.

Sulfur Dioxide



In 1984, the department monitored sulfur dioxide at Scobey and Billings. The department also receives sulfur dioxide data from several companies in accordance with their air quality permits. These companies are monitoring sulfur dioxide in Missoula, East Helena, Colstrip and northwest of Sidney.

In Montana the major sources of sulfur dioxides are coal-fired power plants, oil refineries, sugar beet factories, a lead smelter, a pulp mill, and oil and gas field emissions. Table 33 is a list of the major sulfur dioxide emitting industries throughout Montana.

Scobey

1. In 1976, the department initiated sulfur dioxide monitoring at two sites near Scobey as part of the Poplar River Basin Environmental Impact Study. The sites were temporarily shut down from June, 1983, to July, 1984. The sites are also scheduled to be shut down again in June, 1985. State funding may be available to reopen one site during 1987. In the meantime, the department will operate a network of sulfation plates.

TABLE 33

POINT SOURCE SULFUR DIOXIDE EMISSION ESTIMATES

Source	Tons/Yr	County	City
Exxon Co., USA	16748	Yellowstone	Billings
Montana Power Co. (Corette)	5367	Yellowstone	Billings
Farmers' Union CENEX	8255	Yellowstone	Laurel
Continental Oil Co. (CONOCO)	3872	Yellowstone	Billings
Montana Sulfur	2130	Yellowstone	Billings
Western Sugar	879	Yellowstone	Billings
Westmoreland Resources	* 33	Big Horn	Hardin
East Decker Coal	* 39	Big Horn	Decker
West Decker Coal	* 20	Big Horn	Decker
Simmons Refinery	909	Cascade	Great Falls
WESTCO	1157	Glacier	Cut Bank
Union Oil of California	136	Glacier	Cut Bank
ASARCO	28740	Lewis & Clark	East Helena
Ideal Basic Industries	472	Gallatin	Trident
Kaiser Cement	374	Jefferson	Montana City
Montana Power Colstrip 1&2	4424	Rosebud	Colstrip
Oil and gas flaring	6000	Williston Basin**	
Montana Dakota Utilities	3659	Richland	Sidney
Shell Oil	1186	Richland	Sidney
Perry Petrolane	274	Richland	Sidney
KENCO	55	Roosevelt	Wolf Point
Western Energy Coal	* 46	Rosebud	Colstrip
Peabody Coal	* 18	Rosebud	Colstrip
Montana Power Colstrip #3	1644	Rosebud	Colstrip
ARCO Aluminum	1775	Flathead	Columbia Falls
Champion Int., Packaging Div.	1750	Missoula	Frenchtown
W. R. Grace	373	Lincoln	Libby
Champion International Corp.	25	Lincoln	Libby

*Includes tailpipe emissions from diesel powered vehicles.
**Estimated emissions for oil field gas flaring in the Williston Basin.

2. The two sulfur dioxide sites are the Border site, located on the Canadian border north of Scobey, and the Hanrahan site, 13 miles northeast of Scobey. The sites were originally established to gather baseline data prior to the startup of two 300 megawatt coal-fired power generating units

at Coronach, Saskatchewan. These sites were chosen as possible areas of high sulfur dioxide concentrations based on dispersion modeling performed by a department contractor.

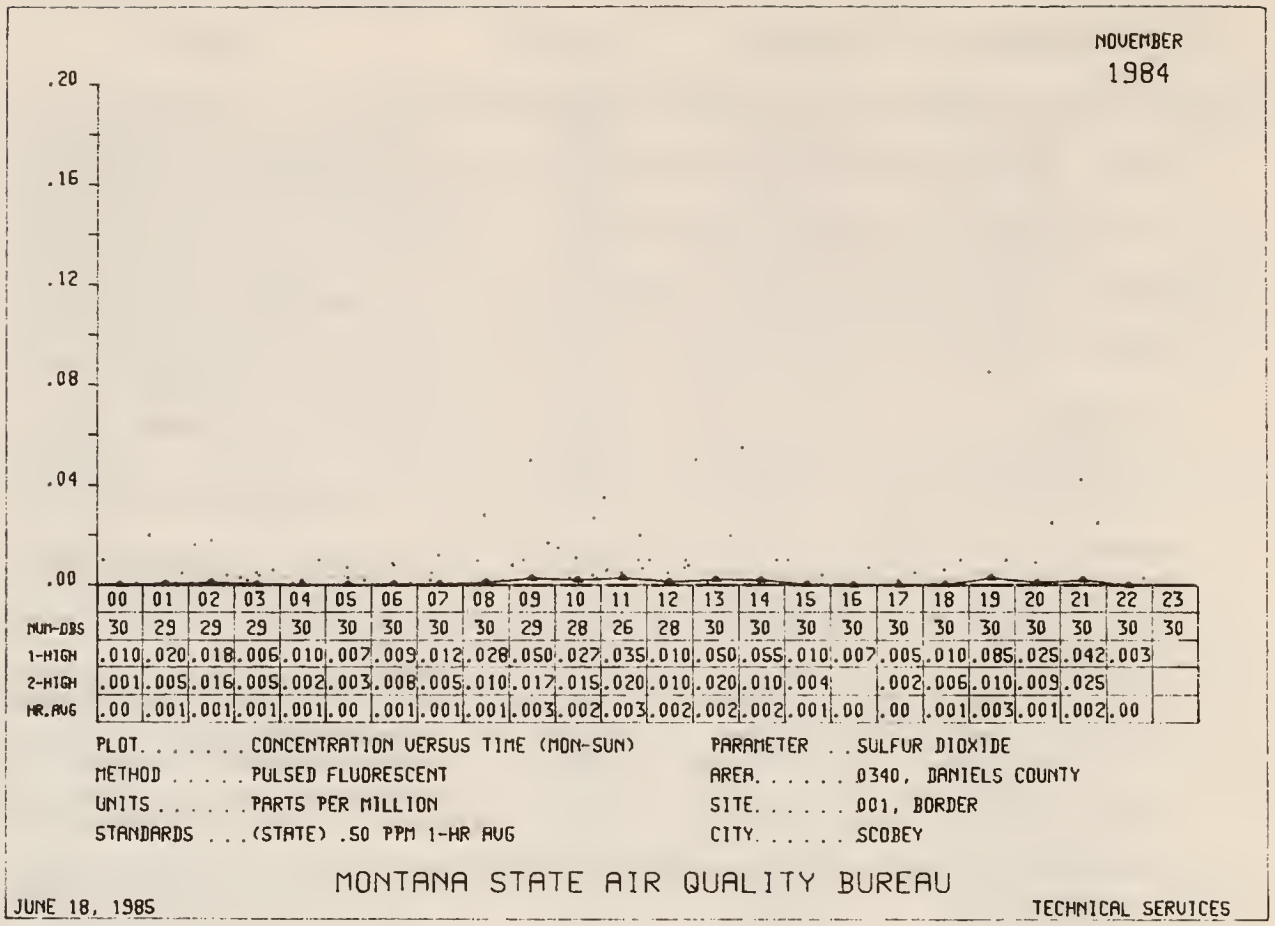
3. During 1984, sulfur dioxide concentrations remained very low at both sites. The maximum one-hour concentrations were 0.085 ppm at the Border site and 0.048 ppm at the Hanrahan site. These readings occurred during November at the Border site and August at the Hanrahan site. Table 34 summarizes the 1984 sulfur dioxide data for the Scobey area. Figure 58 is a diurnal plot of November sulfur dioxide readings from the Border site. The department suggests that this plot be reviewed in conjunction with some of the Billings sulfur dioxide plots. Such a comparison emphasizes just how low the Scobey sulfur dioxide concentrations are.
4. The 1985 Montana Legislature authorized Legacy Fund monies for a scaled down monitoring project for Scobey. The money will not be available until 1987. The funding will be sufficient to operate one site for six to twelve months. During the interim, the department will operate a sulfation plate network.

TABLE 34

SUMMARY OF 1984 SULFUR DIOXIDE DATA FOR SCOBEY

Site	Number of Observations	1-hour Max.	3-hour Max.	Running 24-hr. Max.	Daily Max.	Annual Mean
Border	4346	0.085	0.045	0.012	0.012	0.001
Hanrahan	4014	0.048	0.032	0.012	0.010	0.002

FIGURE 58



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	29	29	29	30	30	30	30	30	29	28	26	28	30	30	30	30	30	30	30	30	30	30	30
1-HIGH	.010	.020	.018	.006	.010	.007	.009	.012	.028	.050	.027	.035	.010	.050	.055	.010	.007	.005	.010	.085	.025	.042	.003	
2-HIGH	.001	.005	.016	.005	.002	.003	.008	.005	.010	.017	.015	.020	.010	.020	.010	.004		.002	.006	.010	.009	.025		
HR.AVG	.00	.001	.001	.001	.001	.00	.001	.001	.001	.003	.002	.003	.002	.002	.002	.001	.00	.00	.001	.003	.001	.002	.00	

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0340, DANIELS COUNTY
SITE. . . . . 001, BORDER
CITY. . . . . SCOBEY

MONTANA STATE AIR QUALITY BUREAU

JUNE 18, 1985 TECHNICAL SERVICES

Billings

1. Sulfur dioxide monitoring has been conducted in Billings and Laurel since 1974. In 1978, the Laurel area was designated nonattainment for the primary national ambient air quality standard for sulfur dioxide. Concurrently, a stipulation was signed between the department and the major sulfur dioxide emitting industries in the vicinity of Billings and Laurel. The stipulation provided for a one-year study to more fully describe the magnitude and geographical extent of sulfur dioxide concentrations. Another major

goal of the study was to identify the relative source contribution from each industry.

2. The study did not get underway until September, 1981. Through a cooperative effort, the affected industries and the department designed and installed an entirely new sulfur dioxide sampling network. The air monitoring portion of the study was performed by GeoResearch Inc. of Billings under subcontract to Rockwell International, and by the department. The air monitoring portion of the study was completed in September, 1982. The results indicated that the Laurel area is in compliance with state and federal sulfur dioxide standards while Billings and Lockwood are exceeding the state standards. However, the department is still analyzing the data to determine what percentage of the sulfur dioxide concentrations at each monitoring site originate from each industry.

3. Since 1982, the department has operated a scaled-down sulfur dioxide network. The department stopped all sulfur dioxide monitoring in Laurel and ran four sites in the Billings and Lockwood areas. In December, 1983, the network was reduced even further to three sites. The department shut down all of the Laurel sites because the data indicated compliance with all state and federal standards. The present network consists of the Coburn Road, Lockwood Park, and North Johnson Lane sites (see Figure 49).

4. The 1977 stipulation required the department to validate a mathematical model so that the model predicts actual concentrations reasonably well. The department was to use the validated model to determine the sulfur dioxide contribution from each emission source and to subsequently design control strategies. During 1983 and 1984, the department pursued two different modeling approaches: dispersion modeling using the standard Complex I and Complex II EPA-approved models and a directional model

developed by the department. The results of both analyses are described in detail in a report entitled "Billings SO_2 Study, Data Analysis, Model Validation, and Source Determination (Draft)."

5. The department chose the Complex I and Complex II models because they are the only EPA-approved models which are designed for multiple emission sources, hourly sequential emission and meteorological data, and rough terrain. The department obtained emissions data from each of the industries and used a composite meteorological data set based on the Taft School site for input to the model.

   The department ran the Complex models to predict twenty-four hour concentrations for November, 1981, and January, May and August, 1982. The department compared the predicted concentration at each monitoring site to the actual concentrations using linear regression analyses. The results of the analyses were disappointing. The models generally underpredicted and the correlation coefficients were very poor. The department also believed that the source contribution percentages were unrealistic.

   The department suspects that the models performed poorly for several reasons including: 1) the models overpredict plume rise, 2) the models are not designed to handle inversion breakups (fumigation), and 3) the receptors are so close to the sources that small errors in wind direction can result in large differences in predicted versus actual concentrations.

   The ambient sulfur dioxide and meteorological data indicate that a large share of the ambient sulfur dioxide concentrations occur during fumigations. With this in mind, the department and the Billings industries decided to execute the models for the Laurel BN site and the Coburn Road site only during periods with steady winds greater than three meters per second and blowing from the sources to the site. Since

dispersion models were designed for these conditions, all parties felt that if the models were to work at all, they would work under these conditions. The results were even more disappointing. The correlations were even worse and, in some cases, negative.

The industries remain optimistic that a dispersion model can be validated but the department is skeptical.

6. The second modeling approach pursued was developed by the department. The department based the model on the Coburn Road site in Billings and the BN site in Laurel. These sites recorded the highest sulfur dioxide readings in their respective areas.

   The department determined that approximately 90 percent of the sulfur dioxide concentrations registered at the Coburn Road and Laurel BN sites occurred during southwest or northeast winds. The department arrived at this conclusion by developing a parameter known as a "percent strength factor." The strength factor is the mean of the sulfur dioxide readings (from one of 16 compass directions) times the percent of time the wind blew from the applicable direction. The percent strength factor is obtained by adding up the individual strength factors and dividing each by the total times 100. Table 35 shows the percent strength factors for the southwest and northeast directions.

TABLE 35

PERCENT STRENGTH FACTOR FOR COBURN ROAD

	SW	NE	SW + NE
January	56.7%	38.7%	95.4%
May	51.0	33.4	84.4
August	34.6	48.9	83.5
November	81.4	9.7	91.1
Average	55.9%	32.6%	88.5%

The department divided the sulfur dioxide sources into three subareas (Laurel, Billings, and Lockwood) to allow for a directional analysis. Therefore, at Coburn Road, the following equations are appropriate.

$$\frac{SW}{NE} = \frac{55.9}{32.6} = 1.71 = \frac{A + B}{C} \quad \text{and}$$

$$A + B + C = 0.29 \text{ ppm}$$

where: SW and NE = percent strength factors from each direction

A = Laurel
B = Billings = the annual contribution of sulfur dioxide from each subarea
C = Lockwood

0.029 ppm = the annual average concentration at Coburn Road

Since the Taft School site is located between the Laurel emission sources (area A) and the Billings emission sources (area B), the department considered that all of the sulfur dioxide recorded at Taft School during southwest winds was from Laurel. The average concentration recorded during southwest winds was 0.004 ppm. Since the Taft School site and the Coburn Road site are near each other in relationship to Laurel, the department assumed 0.004 ppm was the concentration at Coburn from Laurel. The department then solved the two equations above simultaneously and obtained the following results for Coburn Road:

A = 0.004 ppm
B = 0.014 ppm
C = 0.011 ppm

Since two of the areas had more than one emission source, the department determined source specific contributions based on plant emission rates. A similar procedure was used for the Laurel BN site and the results for both sites are shown in Table 36. This analysis indicates that the Exxon Refinery and the Montana Power Co. Corette Plant are the primary sources

TABLE 36

PERCENT CONTRIBUTION TO AMBIENT SULFUR DIOXIDE CONCENTRATIONS BY SOURCE

Emission Source	Coburn Road	Laurel BN
Montana Power Co.	27.4%	5.8%
Conoco	18.0%	3.8%
Western Sugar	2.8%	0.6%
Exxon	29.0%	8.9%
Montana Sulphur	8.8%	2.7%
CENEX	13.8%	78.0%

impacting the Coburn Road site. The department must point out, however, that this technique does not consider dispersion, vertical mixing, or the relationship between source and receptor heights.

7. The department is presently investigating other dispersion models as well as refinements in the Complex I and II models to better identify source contributions. The existence of a validated dispersion model would have two advantages over the department's directional model in that it could predict sulfur dioxide concentrations at any location and would be a valuable future planning tool.

8. The Coburn Road site is located on the top of a ridge which separates the city of Billings from the Lockwood area. The Conoco oil refinery, the Montana Power Co. Corette Plant, and the Western Sugar refinery are sulfur dioxide sources which are located on the Billings side of the ridge within two miles of the monitoring site. On the other side of the ridge in Lockwood are the Exxon oil refinery and the Montana Sulphur and Chemical Company. Both of these sulfur dioxide sources are approximately two miles northeast of the Coburn Road site.

   The site is at an elevation of 3380 feet MSL or approximately 280 feet above the surface of the Yellowstone Valley. Wind patterns at the Coburn

Road site are somewhat different than at the other sites located within the valley. In general, the wind speed is 0.5 to 1.0 meter per second faster with a much greater predominance from the west-southwest. Apparently, terrain features have much less effect on wind at the Coburn Road site.

9. In 1984, the mean sulfur dioxide concentration at Coburn Road was the highest in the state (see Table 37). The Coburn Road monitor also recorded significant short-term levels of sulfur dioxide. During 1984, sulfur dioxide concentrations at the Coburn Road site were in violation of the Montana twenty-four hour standard (see Table 38). Figures 59, 60 and 61 show the diurnal distributions of sulfur dioxide concentrations at Coburn Road for March, September and December, 1984. It can be observed from these plots that winter concentrations are higher than summer and that peak concentrations generally occur before noon. However, the diurnal concentrations are more erratic during December.

TABLE 37

SUMMARY OF 1984 SULFUR DIOXIDE DATA FOR BILLINGS

Site	No. of Observations	1-hour Max.	3-hour Max.	Running 24-hr. Max.	Daily Max.	Annual Mean
North Johnson Lane	5334	0.520	0.448	0.118	0.111	0.018
Lockwood Park	5968	0.550	0.293	0.110	0.081	0.023
Coburn Road	4609	0.438	0.300	0.121	0.118	0.026

TABLE 38

1984 EXCEEDANCES OF SULFUR DIOXIDE STANDARDS IN BILLINGS

Site	Montana 1-hour Standard[1]	Montana 24-hour Standard[2]	Montana Annual Standard[3]	Federal 3-hour Standard[2]	Federal Daily Standard[2]	Federal Annual Standard
North Johnson Lane	1	1	0	0	0	0
Lockwood Park	1	1	0	0	0	0
Coburn Road	0	3	0	0	0	0

1 Eighteen excursions over the standard are allowed before a violation exists.
2 One excursion over the standard is allowed before a violation exists.
3 Although sulfur dioxide concentrations exceeded the annual standard at Lockwood Park and Coburn Road, there was insufficient data to constitute a valid annual average.

FIGURE 59

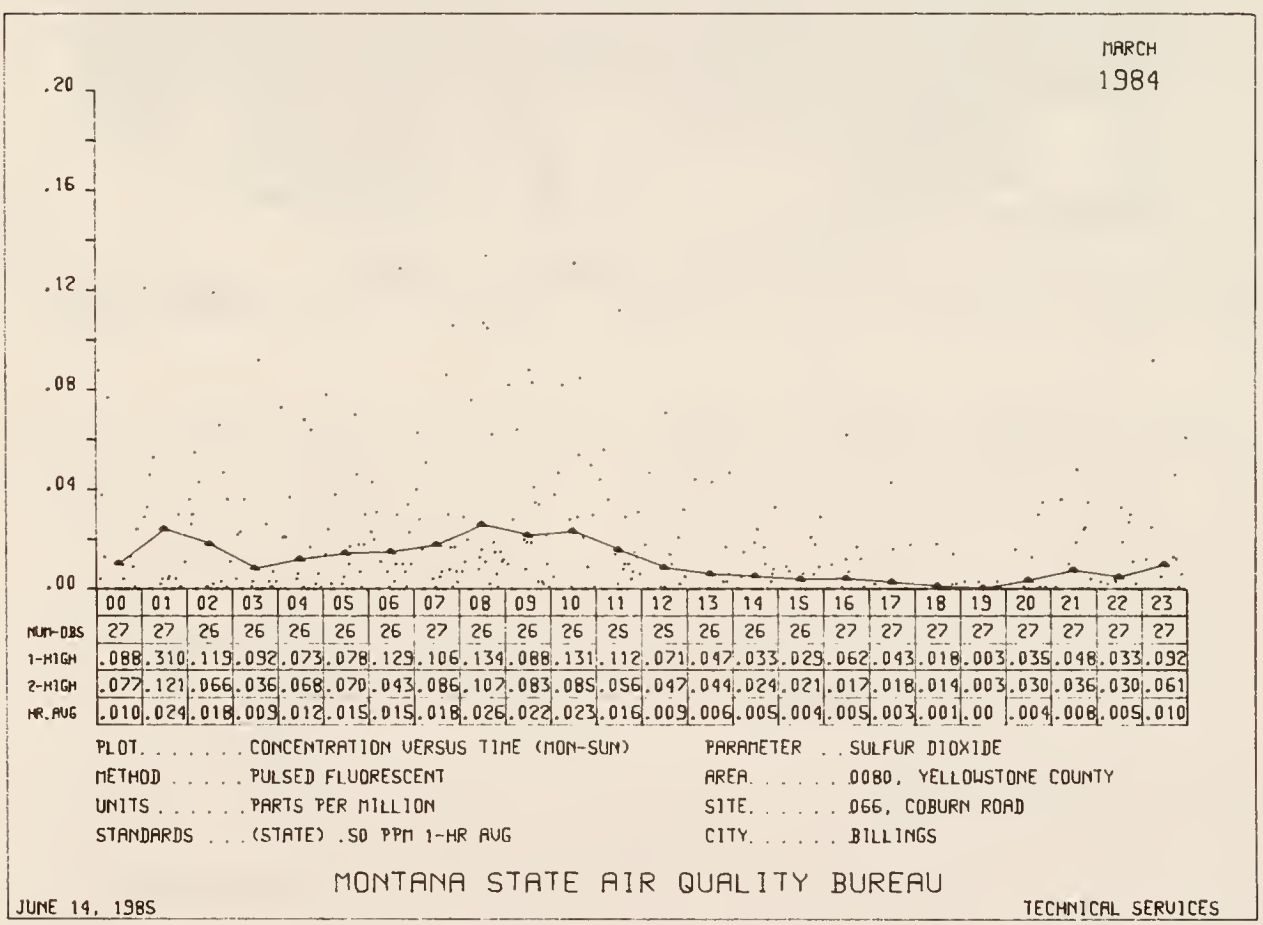
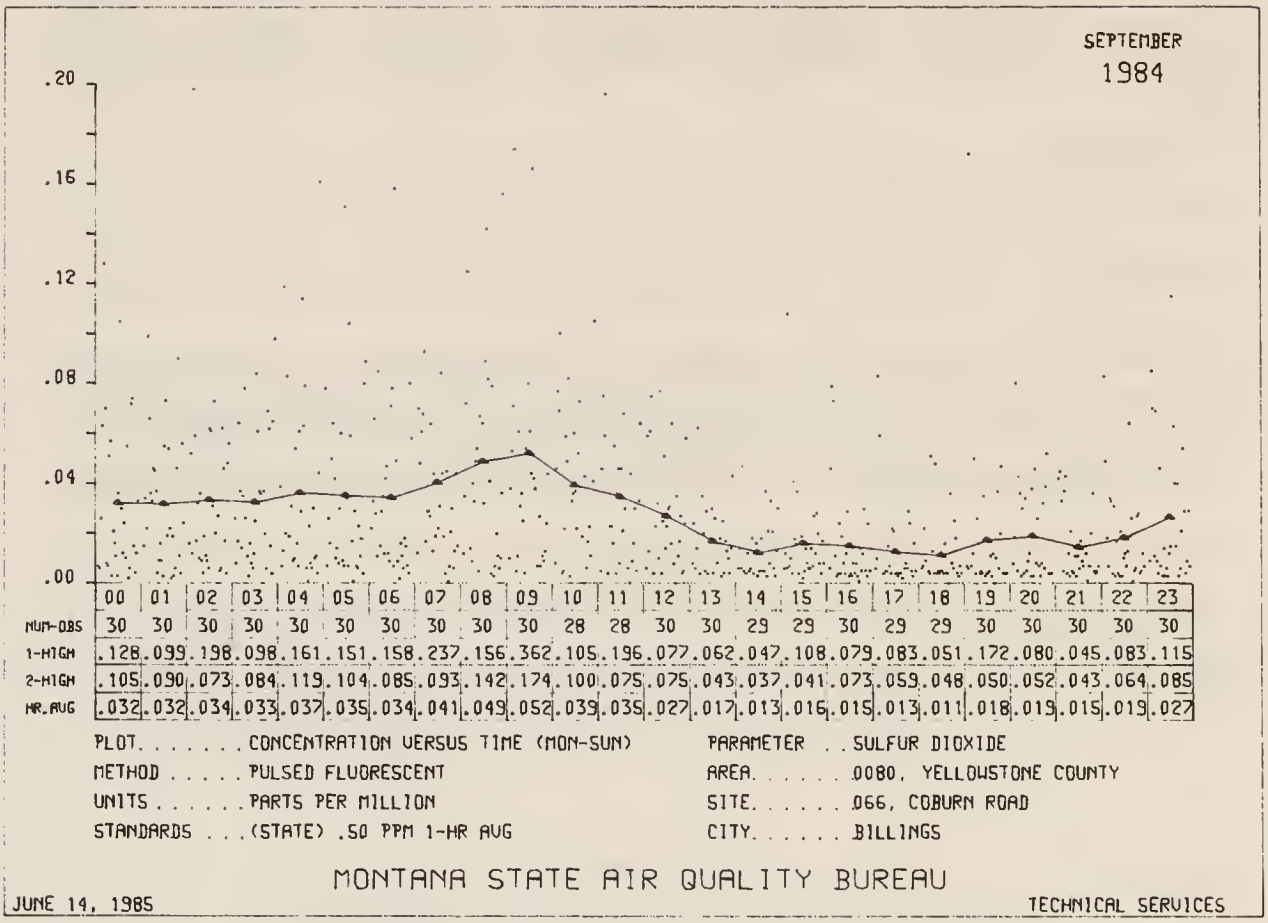


FIGURE 60



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	30	30	28	28	30	30	29	29	30	29	29	30	30	30	30	30
1-HIGH	.128	.099	.198	.098	.161	.151	.158	.237	.156	.362	.105	.196	.077	.062	.047	.108	.079	.083	.051	.172	.080	.045	.083	.115
2-HIGH	.105	.090	.073	.084	.119	.104	.085	.093	.142	.174	.100	.075	.075	.043	.037	.041	.073	.059	.048	.050	.052	.043	.064	.085
HR.AVG	.032	.032	.034	.033	.037	.035	.034	.041	.049	.052	.039	.035	.027	.017	.013	.016	.015	.013	.011	.018	.019	.015	.019	.027

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

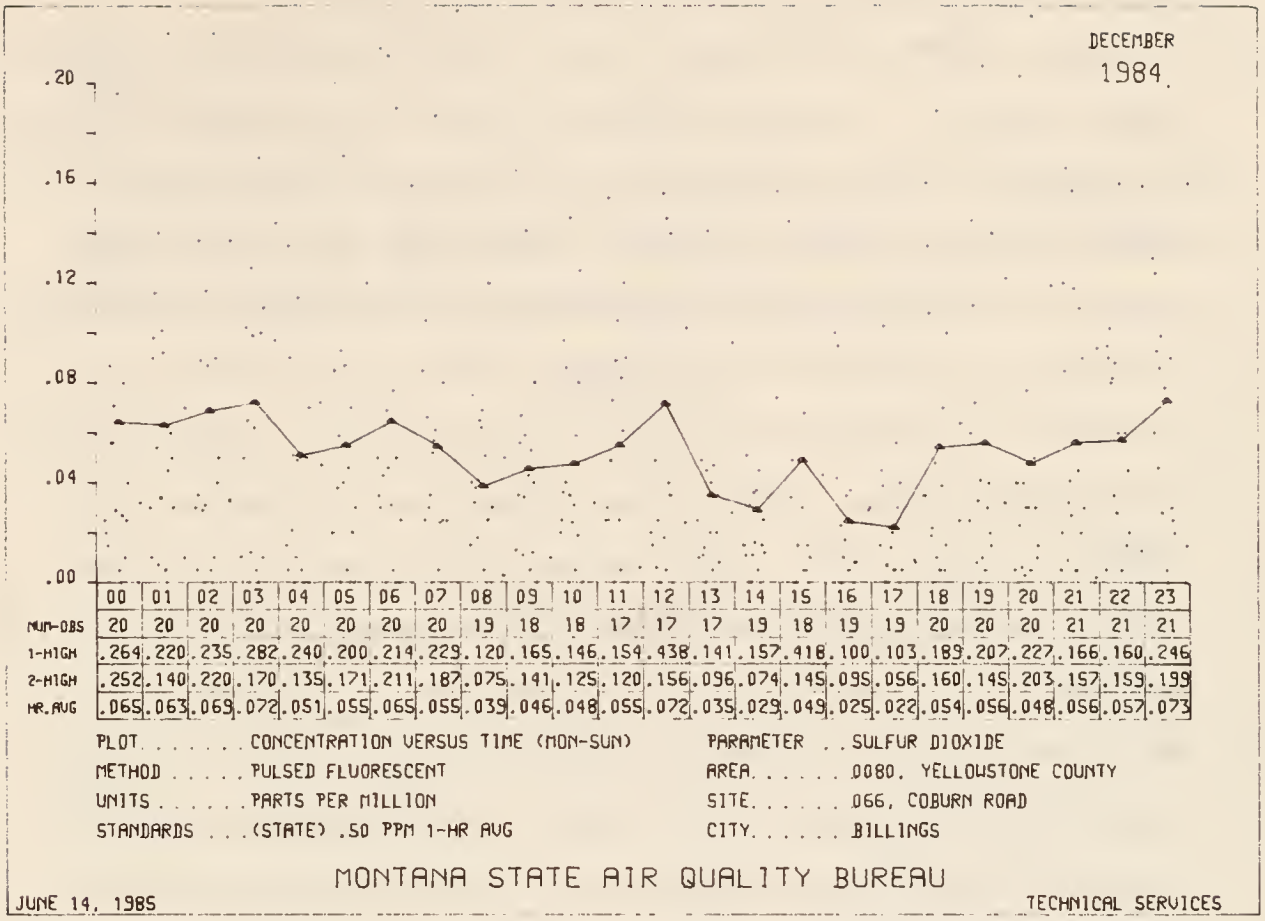
PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE COUNTY
SITE. . . . . 066, COBURN ROAD
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

JUNE 14, 1985

TECHNICAL SERVICES

FIGURE 61



10. The department suspects that the elevation of the Coburn Road site is optimum, so that during periods of multiple layered inversions, the plumes of the various sources are trapped in a layer at the same height. This might explain why sulfur dioxide concentrations at Coburn Road are generally higher and often do not follow the concentrations at the other valley locations.

11. Since Coburn Road consistently records high sulfur dioxide concentrations, the department intends to continue to monitor sulfur dioxide at this

location. In addition, the site will be the key site in determining the amount of sulfur dioxide control necessary at each plant.

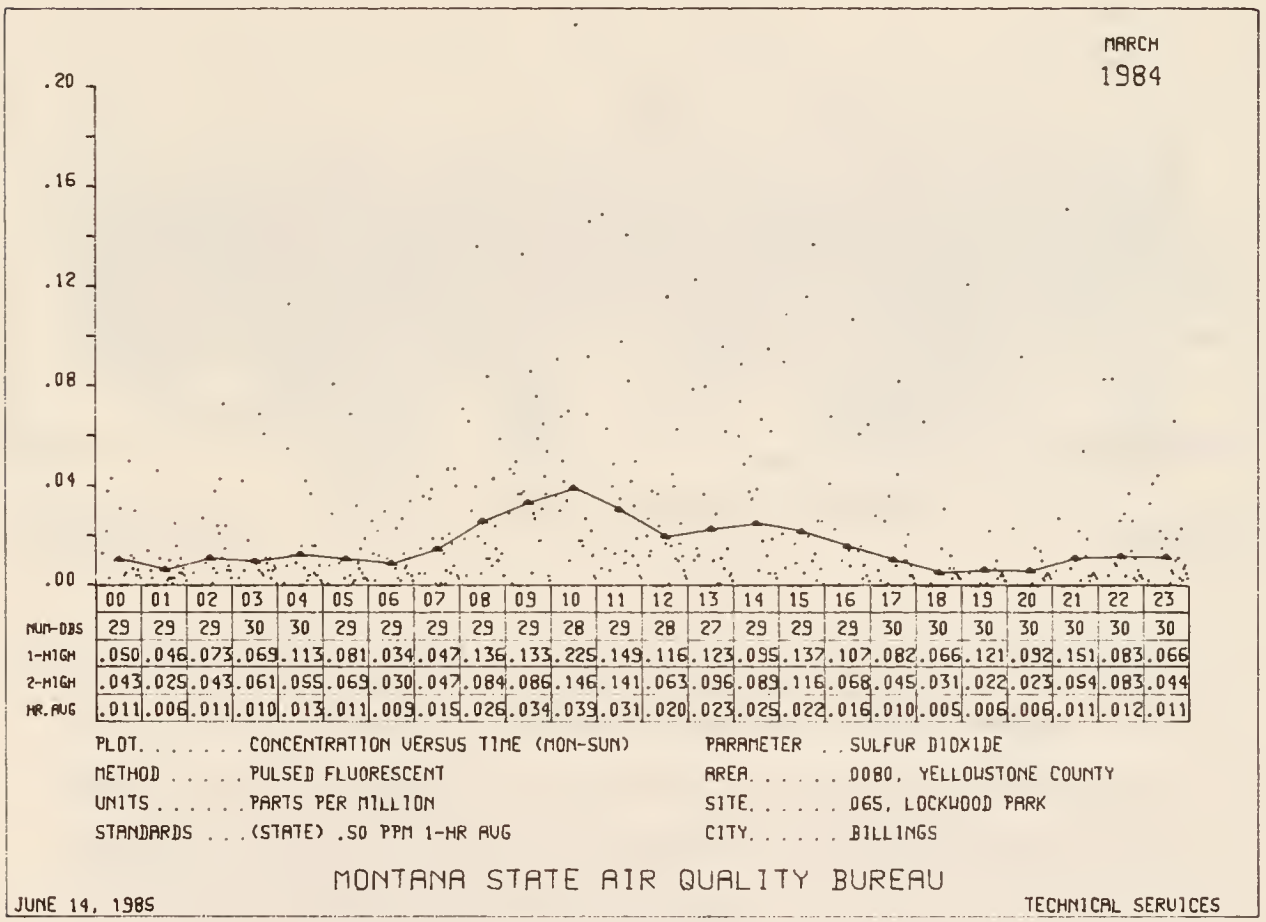
12. The Lockwood Park site is located in the northwest corner of the Lockwood Little League Park. The site is near the center of the Lockwood area and approximately 0.5 mile south-southeast of the Exxon Refinery and the Montana Sulphur and Chemical Company. The Billings area sulfur dioxide sources lie 3.5 miles to the southwest over the ridge that the Coburn Road site lies on. Emissions from the Billings sources must either rise over the ridge or go north around the ridge and west through a constriction in the Yellowstone Valley. Winds at the Lockwood Park site averaged 2.4 meters per second in 1982. The predominant wind direction is from the south to the west-southwest with a secondary predominance from the northeast.

13. The Lockwood Park site recorded the highest one-hour sulfur dioxide concentration for the entire state in 1984. Table 37 summarizes the sulfur dioxide concentrations at Lockwood Park. There were no violations of state and federal ambient standards during 1984. The annual average was above the Montana standard but insufficient data was gathered to establish a valid annual average. Figures 62, 63 and 64 display diurnal plots of sulfur dioxide concentrations at the Lockwood Park site for March, September and December, 1984. Similar to the Coburn Road site, the peak concentrations occur during the morning, usually between 9:00 a.m. and 12:00 noon. Also similar to the Coburn Road site, the December hourly readings were more erratic than March or September readings. The department suspects that during December the sun's angle is so low that surface heating is insufficient to eliminate temperature inversions. As mentioned

earlier, during inversion breakups, Billings often records high concentrations. During other times of the year, inversion breakups occur during the morning and result in high concentrations.

14. The department plans to continue to operate the Lockwood Park NAMS site. The relatively high sulfur dioxide readings and its location near the center of population for Lockwood make the site essential.

FIGURE 62



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	29	29	29	30	30	29	29	29	29	29	28	29	28	27	29	29	29	30	30	30	30	30	30	30
1-HIGH	.050	.046	.073	.069	.113	.081	.034	.047	.136	.133	.225	.149	.116	.123	.095	.137	.107	.082	.066	.121	.092	.151	.083	.066
2-HIGH	.043	.025	.043	.061	.055	.069	.030	.047	.084	.086	.146	.141	.063	.096	.089	.116	.068	.045	.031	.022	.023	.054	.083	.044
HR.AVG	.011	.006	.011	.010	.013	.011	.009	.015	.026	.034	.039	.031	.020	.023	.025	.022	.016	.010	.005	.006	.006	.011	.012	.011

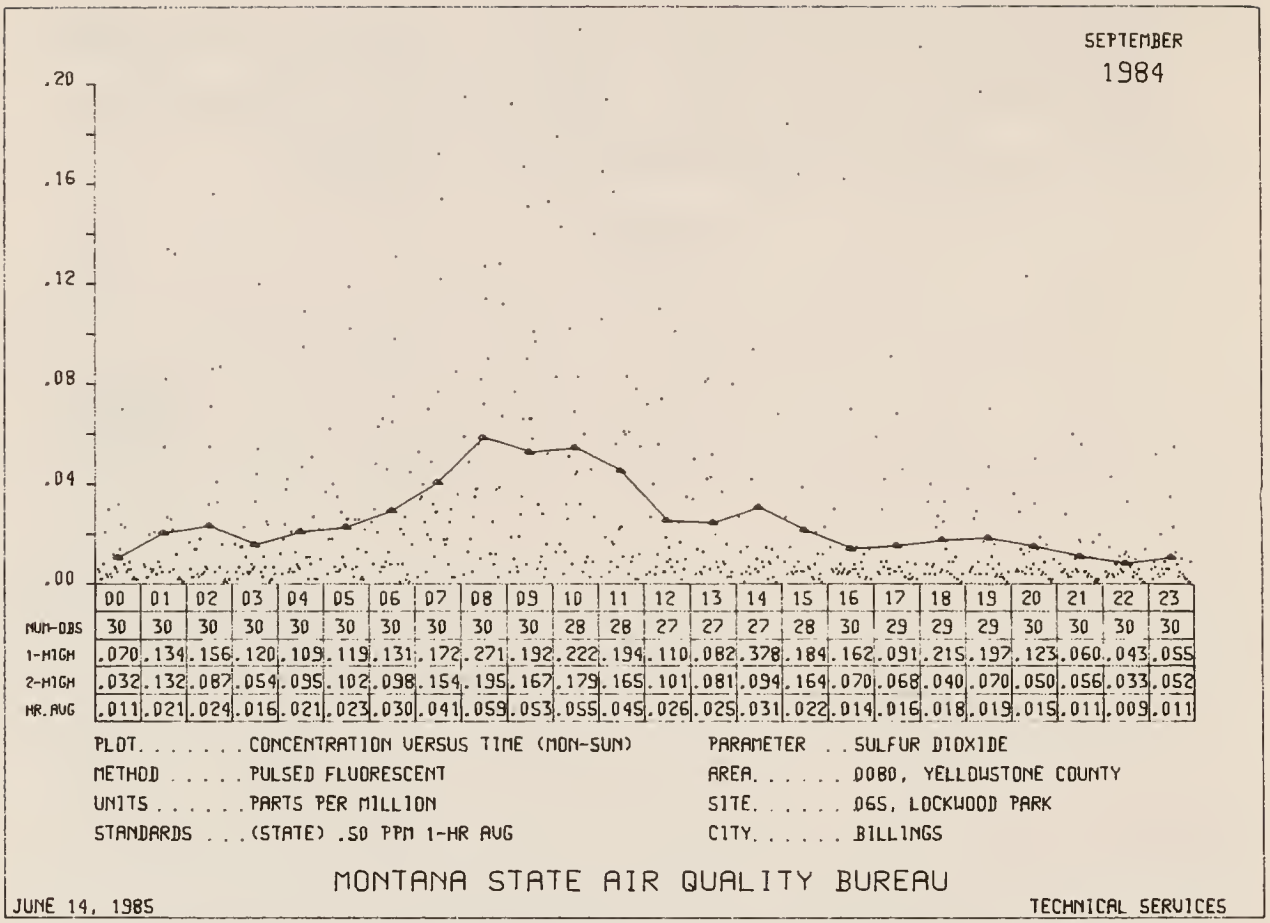
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE COUNTY
SITE. . . . . 065, LOCKWOOD PARK
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

JUNE 14, 1985 TECHNICAL SERVICES

FIGURE 63



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	30	30	28	28	27	27	27	28	30	29	29	29	30	30	30	30
1-HIGH	.070	.134	.156	.120	.109	.119	.131	.172	.271	.192	.222	.194	.110	.082	.378	.184	.162	.091	.215	.197	.123	.060	.043	.055
2-HIGH	.032	.132	.087	.054	.095	.102	.098	.154	.195	.167	.179	.165	.101	.081	.094	.164	.070	.068	.040	.070	.050	.056	.033	.052
HR.AVG	.011	.021	.024	.016	.021	.023	.030	.041	.059	.053	.055	.045	.026	.025	.031	.022	.014	.016	.018	.019	.015	.011	.009	.011

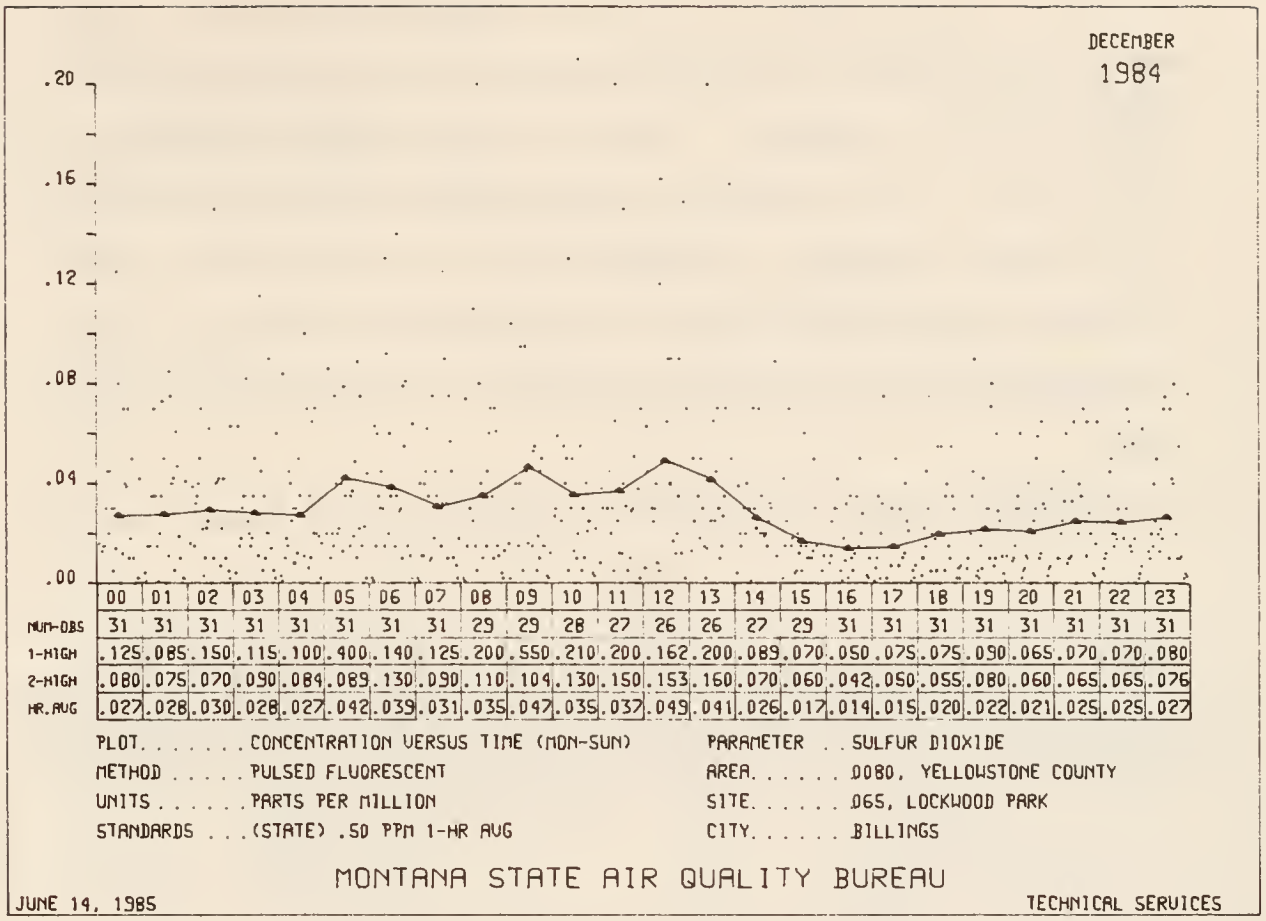
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE COUNTY
SITE. . . . . 06S, LOCKWOOD PARK
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

JUNE 14, 1985 TECHNICAL SERVICES

FIGURE 64



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	31	31	29	29	28	27	26	26	27	29	31	31	31	31	31	31	31	31
1-HIGH	.125	.085	.150	.115	.100	.400	.140	.125	.200	.550	.210	.200	.162	.200	.089	.070	.050	.075	.075	.090	.065	.070	.070	.080
2-HIGH	.080	.075	.070	.090	.084	.089	.130	.090	.110	.104	.130	.150	.153	.160	.070	.060	.042	.050	.055	.080	.060	.065	.065	.076
HR.AVG	.027	.028	.030	.028	.027	.042	.039	.031	.035	.047	.035	.037	.049	.041	.026	.017	.014	.015	.020	.022	.021	.025	.025	.027

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE COUNTY
SITE. . . . . 065, LOCKWOOD PARK
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

JUNE 14, 1985 TECHNICAL SERVICES

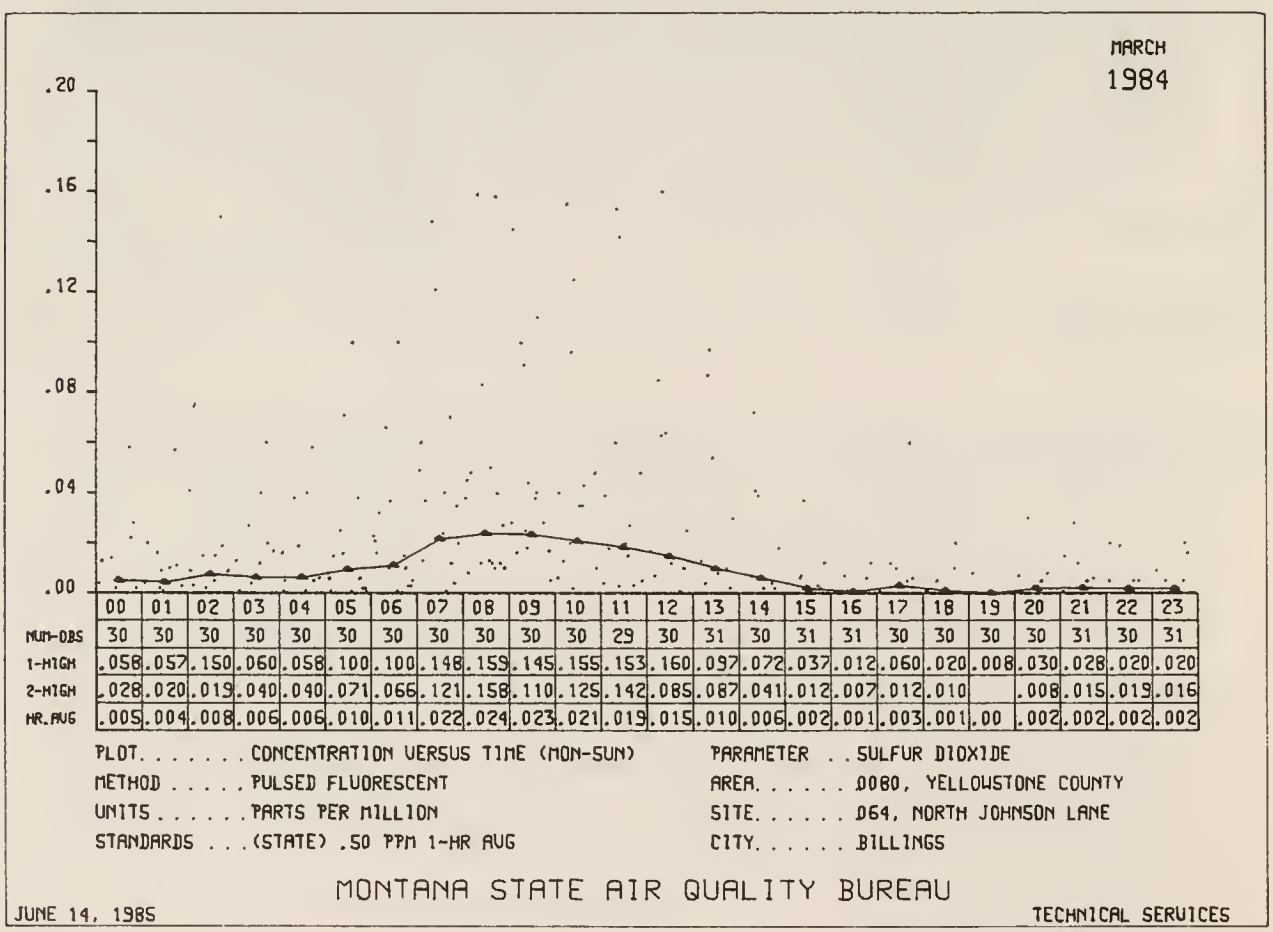
15. The North Johnson Lane site is located in a field one mile northeast of the Exxon refinery and the Montana Sulphur and Chemical Company. It is also 4.5 miles northeast of the Billings area sulfur dioxide sources. The immediate area around the site is undeveloped with the exception of an asphalt batch plant 200 yards to the north.

Winds at North Johnson Lane are predominantly from the southwest and to a lesser extent from the northeast. The average wind speed during 1982 was 2.8 meters per second. This is slightly higher than at Lockwood Park, but lower than Coburn Road.

16. During 1984, the North Johnson Lane site registered the highest three-hour sulfur dioxide reading for the entire state (see Table 37). Sulfur dioxide concentrations at the North Johnson Lane site complied with all state and federal standards. Figures 65, 66 and 67 show the diurnal distributions of sulfur dioxide concentrations at the North Johnson Lane site for March, September, and December, 1984. As with the other sites, the highest concentrations occur in the morning from 8:00 a.m. to noon. The December plot was erratic and, therefore, also similar to the other sites.

17. The department intends to continue to operate the North Johnson Lane site.

FIGURE 65



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	30	30	30	29	30	31	30	31	31	30	30	30	30	31	30	31
1-HIGH	.058	.057	.150	.060	.058	.100	.100	.148	.159	.145	.155	.153	.160	.097	.072	.037	.012	.060	.020	.008	.030	.028	.020	.020
2-HIGH	.028	.020	.019	.040	.040	.071	.066	.121	.158	.110	.125	.142	.085	.087	.041	.012	.007	.012	.010		.008	.015	.019	.016
HR.AVG	.005	.004	.008	.006	.006	.010	.011	.022	.024	.023	.021	.019	.015	.010	.006	.002	.001	.003	.001	.00	.002	.002	.002	.002

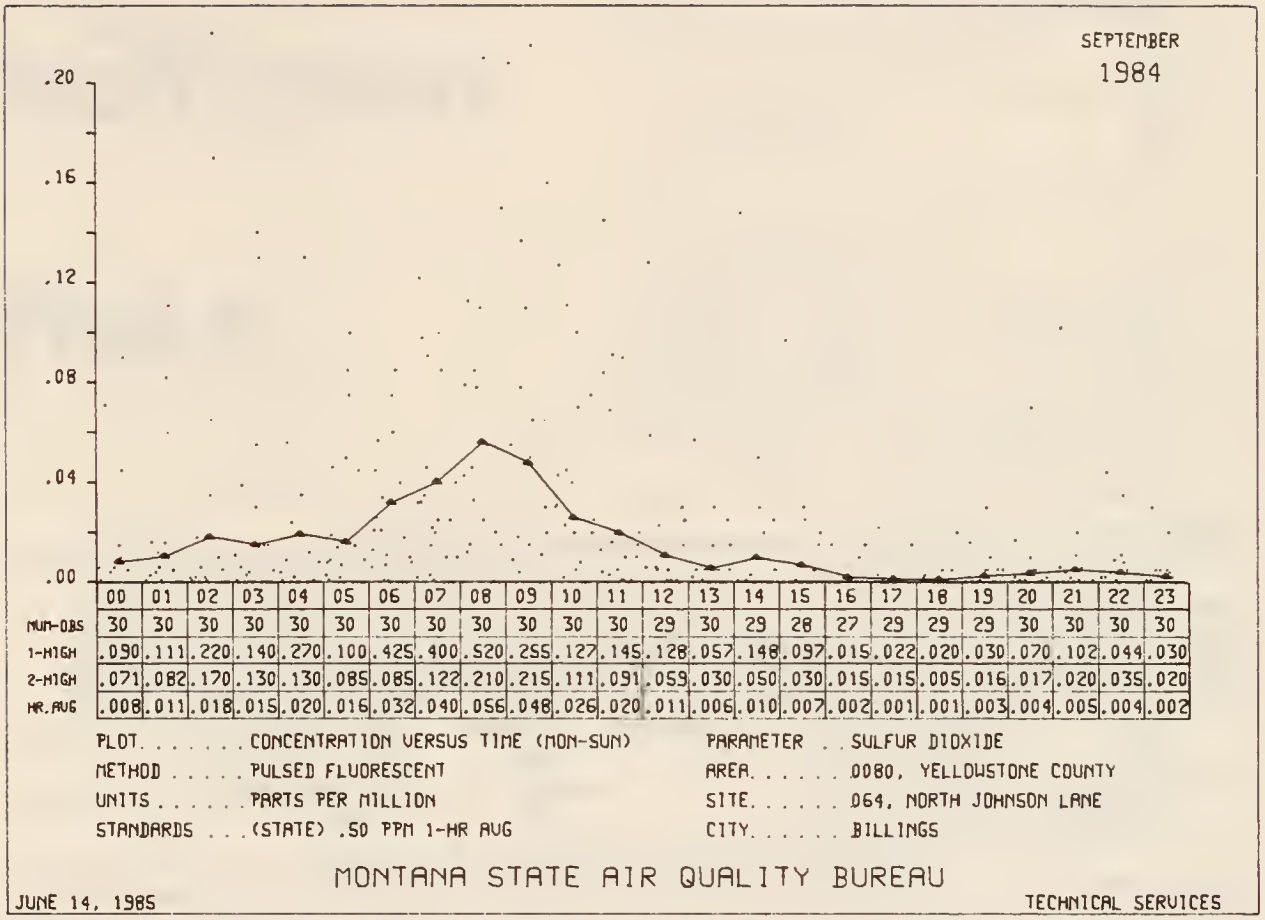
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE COUNTY
SITE. . . . . 064, NORTH JOHNSON LANE
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

JUNE 14, 1985 TECHNICAL SERVICES

FIGURE 66



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	30	30	30	30	29	30	29	28	27	29	29	29	30	30	30	30
1-HIGH	.090	.111	.220	.140	.270	.100	.425	.400	.520	.255	.127	.145	.128	.057	.148	.097	.015	.022	.020	.030	.070	.102	.044	.030
2-HIGH	.071	.082	.170	.130	.130	.085	.085	.122	.210	.215	.111	.091	.059	.030	.050	.030	.015	.015	.005	.016	.017	.020	.035	.020
HR.AVG	.008	.011	.018	.015	.020	.016	.032	.040	.056	.048	.026	.020	.011	.006	.010	.007	.002	.001	.001	.003	.004	.005	.004	.002

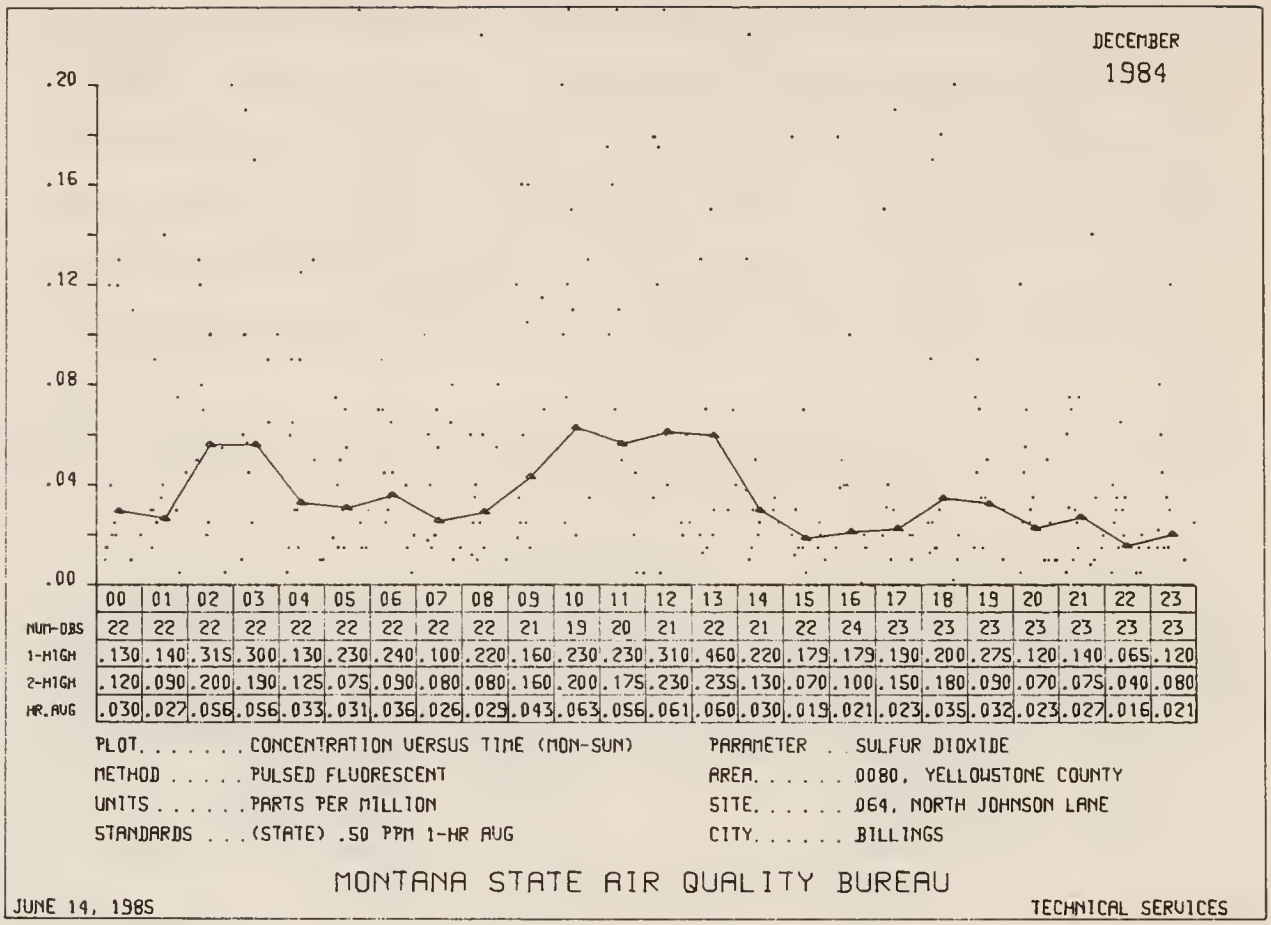
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE COUNTY
SITE. . . . . 064, NORTH JOHNSON LANE
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

JUNE 14, 1985 TECHNICAL SERVICES

FIGURE 67



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	22	22	22	22	22	22	22	22	22	21	19	20	21	22	21	22	24	23	23	23	23	23	23	23
1-HIGH	.130	.140	.315	.300	.130	.230	.240	.100	.220	.160	.230	.230	.310	.460	.220	.179	.179	.190	.200	.275	.120	.140	.065	.120
2-HIGH	.120	.090	.200	.190	.125	.075	.090	.080	.080	.160	.200	.175	.230	.235	.130	.070	.100	.150	.180	.090	.070	.075	.040	.080
HR.AVG	.030	.027	.056	.056	.033	.031	.036	.026	.029	.043	.063	.056	.061	.060	.030	.019	.021	.023	.035	.032	.023	.027	.016	.021

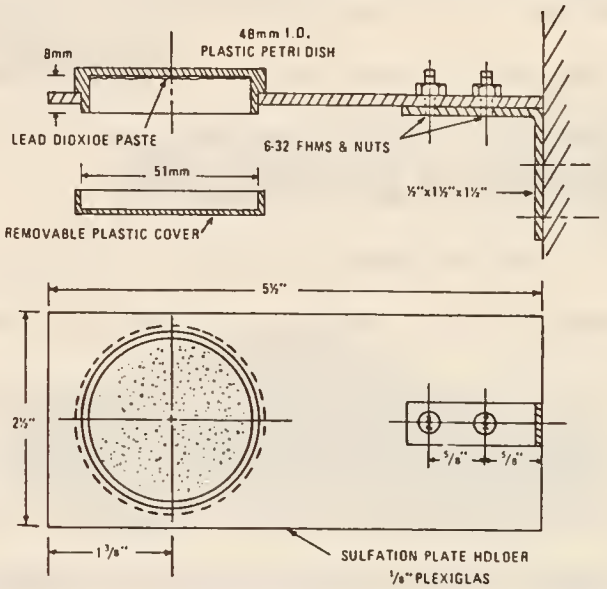
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE COUNTY
SITE. . . . . 064, NORTH JOHNSON LANE
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

JUNE 14, 1985 TECHNICAL SERVICES

Sulfation Rate



In addition to continuous sulfur dioxide monitors, the department will continue to use sulfation plates as inexpensive indicators of sulfur emissions. Yellowstone County intends to continue their network of sulfation plates near Billings and Laurel. Since continuous monitoring of sulfur dioxide is limited to three sites in the Billings and Lockwood areas and none near Laurel, the sulfation plates are even more important.

The department will operate sulfation plate networks near Sidney and Scobey and an individual site at the Circle 8 Guest Ranch near Choteau. The department started the Scobey network in July, 1984, and will run it at least until June, 1987. The department will be able to inexpensively track sulfur dioxide concentrations near Scobey until Legacy Fund monies are available to restart continuous monitoring.

The department recently modified the Sidney network by eliminating all but three sites and starting three new ones. The new sites are located in the

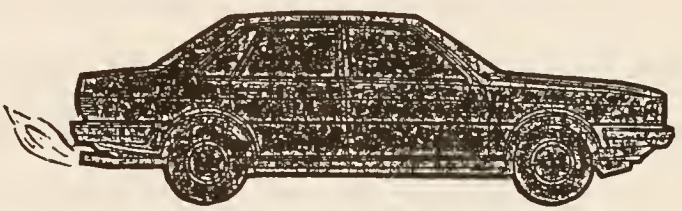
Yellowstone River Valley downstream from Sidney and on the higher terrain to the east. The department believes that winds down the Yellowstone Valley carry sulfur emissions from the Sidney area sources to the new valley locations. On the other hand, several of the sources have tall stacks and may be impacting the higher terrain.

The department maintains a sulfation plate for BLM at the Circle 8 Guest Ranch 30 miles northwest of Choteau. This section of the Rocky Mountain Front is experiencing intensive oil and gas exploration.

The department may occasionally install sulfation plates on a short-term basis in response to odor complaints. Many of the odor complaints we receive involve hydrogen sulfide from oil well venting or other sulfur compounds resulting from incomplete combustion of hydrogen sulfide during flaring. Although sulfation plates are designed to measure sulfur dioxide, they also react with other sulfur compounds, but to a lesser degree. During 1984, the department performed short-term monitoring at oil fields near Oilmont and Dupuyer, Montana.

In Scobey and at some of the other locations, the department has initiated duplicate sampling at each site to eliminate data loss due to the sulfation plates being lost or damaged by the wind. Although the department will continue this practice, in the future we will only analyze one of the plates except for an occasional precision check. This procedure will save money in laboratory charges.

Carbon Monoxide



Automobile exhaust is the principal source of carbon monoxide emissions, although some industries also emit carbon monoxide, and agricultural and forestry burning are contributors in some areas. In some western Montana valleys, residential wood burning is an important source.

The department, with the cooperation of the various county agencies, is currently monitoring carbon monoxide at one location each in Missoula, Great Falls and Billings.

Billings

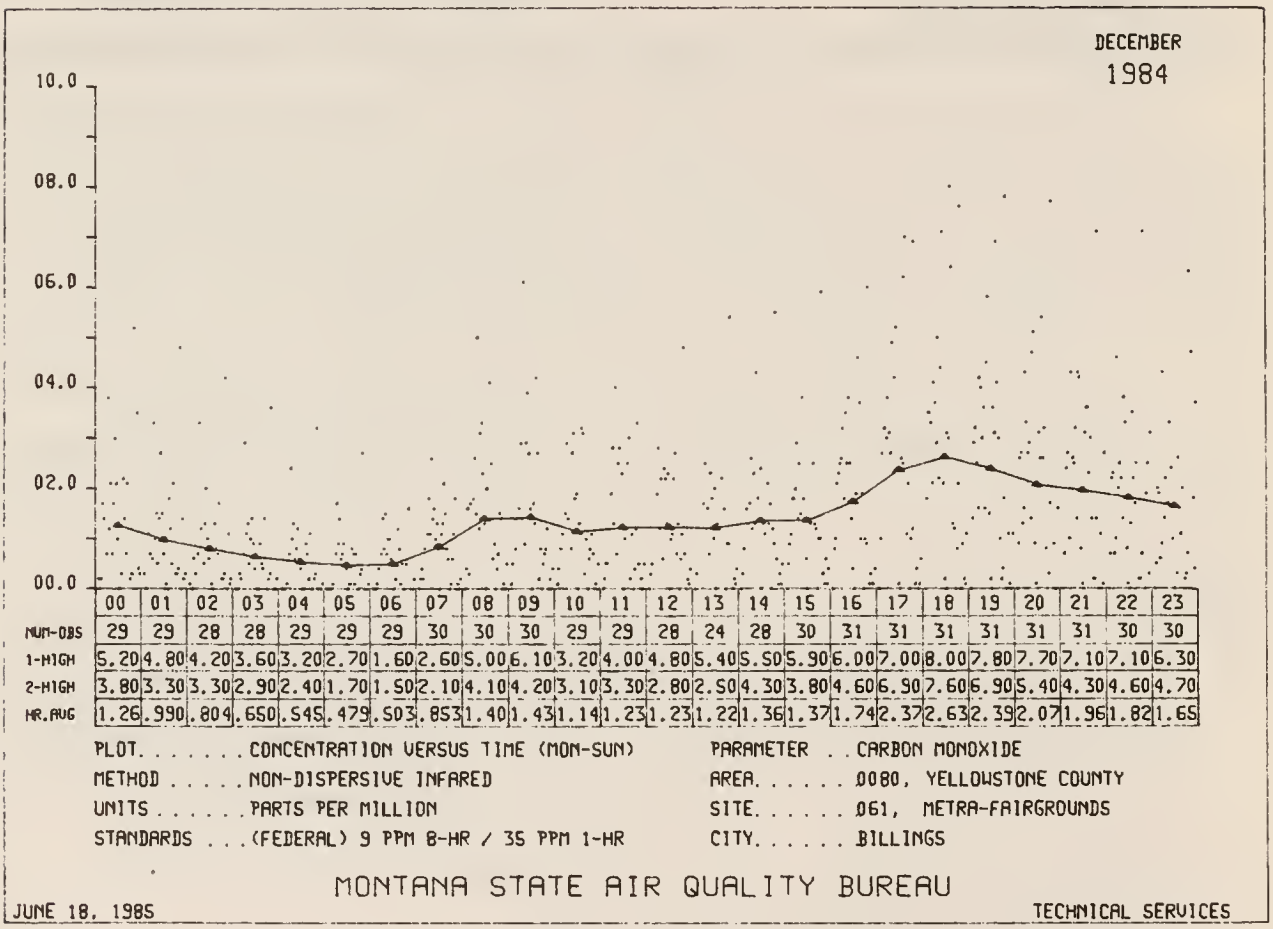
1. The Billings downtown area was designated nonattainment for carbon monoxide due to high readings in the past. These readings were taken at the 27th and Montana site but this site had to be removed due to building construction. A new site was established at the Billings Metra-Fairgrounds complex (see Figure 49).
2. In 1984, an eight-hour high of 7.0 ppm was recorded (see Table 39). Figure 68 shows the diurnal pattern of carbon monoxide concentrations at

TABLE 39

MONTANA CARBON MONOXIDE DATA FOR 1984
(ppm)

City	Site	1-hour Max.	Max. 8-hour Mean
Billings	Metra-Fairgrounds	11.1	7.0
Great Falls	Pardis Clinic	18.8	14.5
Missoula	Boyd Park	16.5	13.3
Libby	Wrecking Yard	9.0	6.7

FIGURE 68



the Fairgrounds site for December, 1984. This plot displays the typical 8:00 a.m. and 5:00 p.m. carbon monoxide peaks associated with traffic. The levels remain high throughout the late night period, which may be attributable to traffic leaving the Metra after evening events, or general areawide carbon monoxide levels.

3. The Fairgrounds site is located some distance from Exposition Drive due to siting problems. Therefore, the relatively low carbon monoxide concentrations observed were expected. The department plans to use data from this site to evaluate emissions from Exposition Drive and to thereby provide control strategy tracking, if necessary. The improvements to Exposition Drive were completed in November, 1983. The department and Yellowstone County experienced a lot of problems with the monitoring equipment during the winter of 1983-1984. Therefore, we only have good data for one winter (1984-1985) since the reconstruction of Exposition Drive was completed, and winter is the time when high carbon monoxide levels occur in Montana. EPA requires two years of ambient data as evidence indicating compliance with ambient standards before the area can be redesignated to attainment. Therefore, the department and Yellowstone County will operate this site at least one more year.

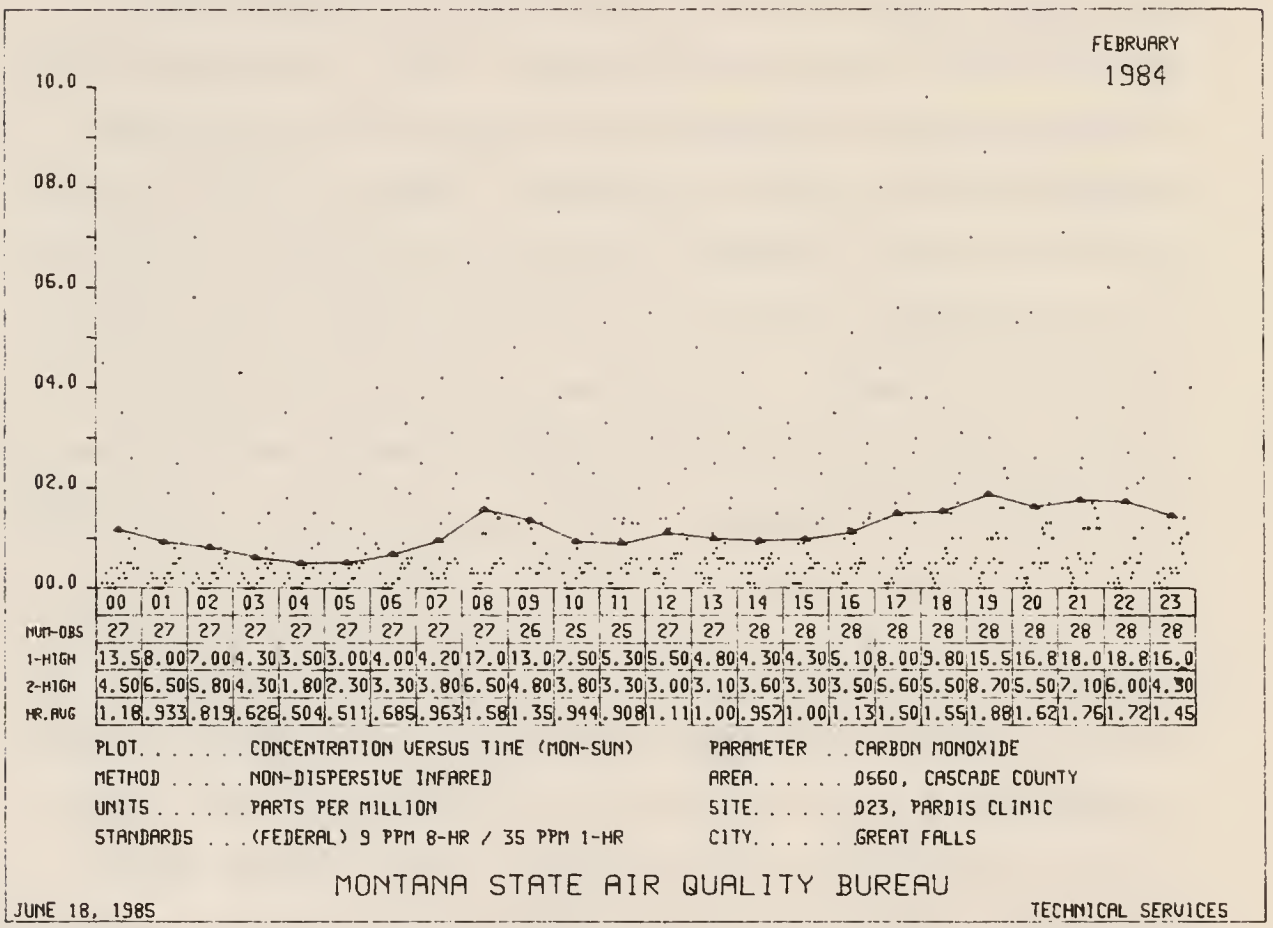
Great Falls

1. In 1979, carbon monoxide sampling was conducted in Great Falls at the Midas Muffler Shop on 10th Avenue South and 9th Street. This site was used to designate the area nonattainment. Due to a leasing problem, the site had to be relocated a short distance away on 10th Avenue South at the Great Falls Federal Savings and Loan Building. In accordance with the 1983 Network Review, the site was moved again to the Pardis Clinic site

(see Figure 44). The department anticipated higher concentrations at this site because it is located at a lower elevation nearer the river and the traffic volume on 10th Avenue South is higher at this location.

2. During 1984, carbon monoxide levels at the Pardis Clinic site were in compliance with all state and federal ambient air quality standards (see Table 39). Figure 69 shows the diurnal distribution of carbon monoxide concentrations at the Pardis Clinic site during February, 1984. The plot

FIGURE 69



shows the expected peaks at 8:00 a.m. and 5:00 p.m. indicating that tailpipe emissions are the major source of carbon monoxide in Great Falls.

3. In the past the department assumed that traffic on 10th Avenue South was responsible for carbon monoxide violations at the Great Falls Federal and the Midas Muffler Shop sites. However, in 1982, the department performed an analysis of carbon monoxide concentrations versus wind speed and direction and uncovered some startling results. Unexpectedly, the highest carbon monoxide concentrations occurred with northeast winds. This wind direction would carry carbon monoxide emissions from 10th Avenue South away from the monitor at the old Great Falls Federal and Midas Muffler Shop sites. Further examination showed that quite often the higher concentrations were associated with a shallow mass of cold air drifting in from the northeast. In fact, during some episodes, winds at Malmstrom Air Force Base, and presumably in Great Falls, were northeast while winds at the Great Falls Airport were still southwest. However, winds at the airport usually shifted northeast during the later stages of the episodes. Since these cold air masses are shallow and moving in from the northeast, winds at the air base (one mile east of Great Falls and at a similar elevation) would shift to the northeast first, followed by Great Falls and finally the airport, which is one mile southwest of the city and 300 feet higher. In light of this information, the department now suspects that the high carbon monoxide concentrations are caused by citywide emissions which are being trapped in the shallow mass of cold air.

4. In 1982, PEDCo Inc. was hired by the Great Falls City-County Planning Board to perform a dispersion model of the carbon monoxide emissions in the vicinity of 10th Avenue South. The results of the model indicate that

the attainment status is questionable at several intersections along 10th Avenue South. PEDCo Inc. pointed out that the average speed of vehicles on 10th Avenue South is critical and that a five mile per hour increase in speed could result in compliance. The department originally believed that the completion of the additional lanes on the 10th Avenue South bridge and a traffic light synchronization project would sufficiently increase the average vehicle speed and solve the problem. In light of paragraph 3 above, the department is now considering new citywide control strategies.

5. In addition, during 1984, the department discovered that the Montana Refining Company (formerly Phillips Petroleum) had not modified their plant to obtain an 8000 ton per year reduction in carbon monoxide. The department included this emission reduction in the original SIP submittal and Phillips Petroleum actually obtained an air quality permit to make the modifications. Unfortunately, the permit was not legally tied to the SIP and Phillips decided not to make the modifications. However, Phillips did install a catalyst promoter which reduced carbon monoxide 5500 tons per year and an FCC preheater which resulted in an additional 1500 tons per year reduction. The department is currently negotiating with Montana Refining Company to issue a permit legally binding them to either the 5500 or 7000 ton per year reduction. Considering additional reductions in automobile tailpipe emissions, the 5500 ton per year reduction will result in compliance with ambient standards in 1986 while the 7000 ton per year reduction would achieve compliance in late 1985.

6. The department and Cascade County will continue to operate the Pardis Clinic site at least two more years. Within two years, carbon monoxide emissions should have decreased to the point where compliance with ambient standards is achieved. As soon as the Pardis Clinic site shows two years

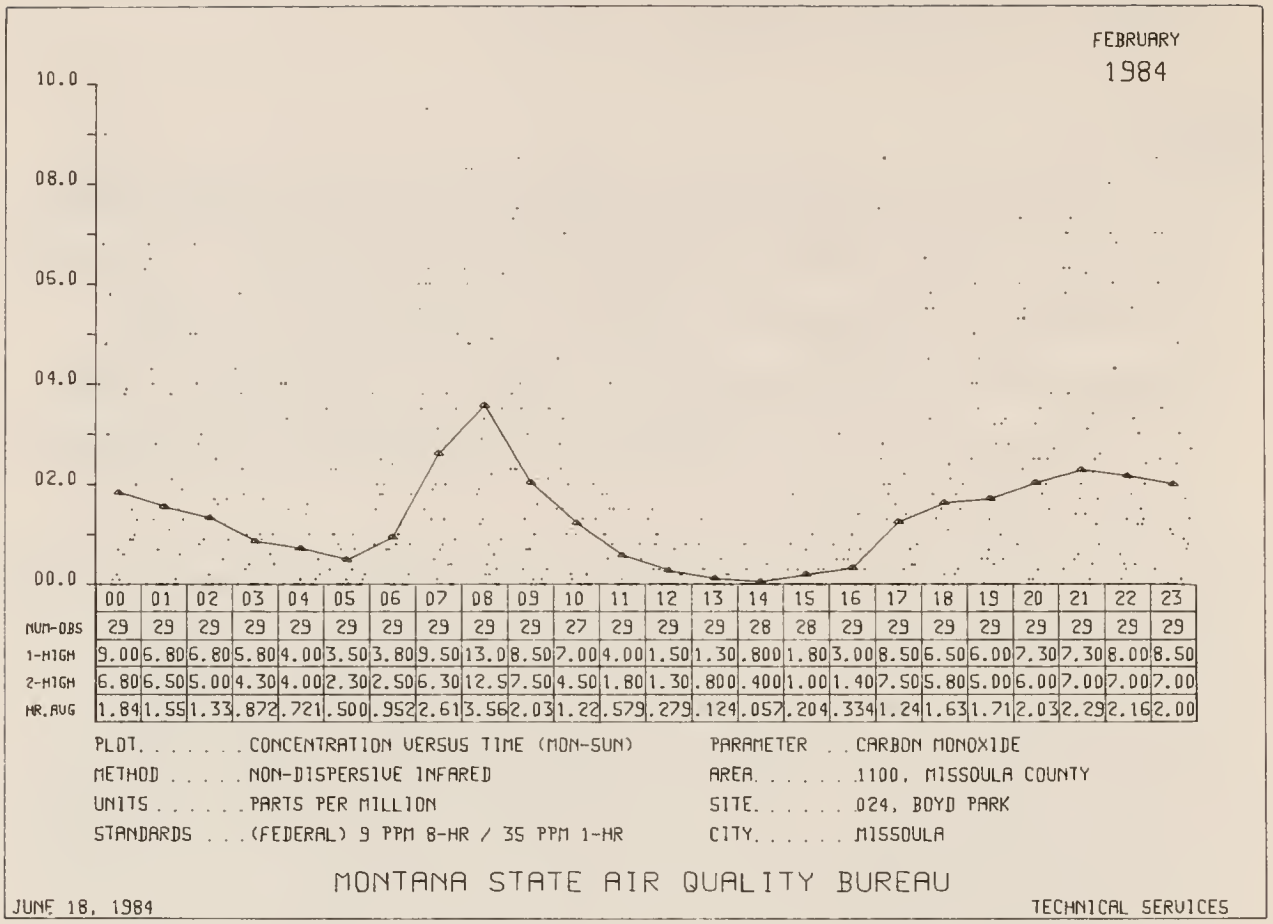
of compliance with ambient standards, the department will submit a redesignation request to EPA. At that time, the department and Cascade County will reconsider the future of the site.

Missoula

1. Part of Missoula was designated nonattainment for carbon monoxide based on high concentrations recorded at the Malfunction Junction site. This site was located near the congested intersection of South Avenue, Russell Street, and U.S. 93. Violations of the 8-hour carbon monoxide standard have also been observed at Lions Park, along Higgins Avenue in the downtown area and at Boyd Park.
2. Figure 70 shows diurnal carbon monoxide concentrations for February, 1984, at the Boyd Park site. In the 1981 Network Review, the department suggested that inversion conditions during the winter have a greater effect on hourly carbon monoxide concentrations than traffic volume and wood burning emissions. The data from 1982 through 1984 seem to substantiate this hypothesis.

   During November through February, Missoula is almost always experiencing poor ventilation. The ability of the airshed to disperse pollutants is limited to a relatively slow constant rate with some improvement during the middle of the day. The department speculates that during the day the emission rate from automobiles and wood burning is almost equal to the rate of dispersal with the exception of the 8:00 a.m. traffic peak. However, after about 3:00 p.m. the emission rate definitely exceeds the dispersion rate and carbon monoxide levels start to climb. After midnight, when emissions are dropping rapidly, the rate of dispersal again exceeds the emissions and concentrations begin to decline.

FIGURE 70



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	29	29	29	29	29	29	29	29	29	29	27	29	29	29	28	28	29	29	29	29	29	29	29	29
1-HIGH	9.00	6.80	6.80	5.80	4.00	3.50	3.80	9.50	13.0	8.50	7.00	4.00	1.50	1.30	.800	1.80	3.00	8.50	6.50	6.00	7.30	7.30	8.00	8.50
2-HIGH	6.80	6.50	5.00	4.30	4.00	2.30	2.50	6.30	12.5	7.50	4.50	1.80	1.30	.800	.400	1.00	1.40	7.50	5.80	5.00	6.00	7.00	7.00	7.00
MR.AVG	1.84	1.55	1.33	.872	.721	.500	.952	2.61	3.56	2.03	1.22	.579	.279	.124	.057	.204	.334	1.24	1.63	1.71	2.03	2.29	2.16	2.00

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . NON-DISPERSIVE INFARED
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (FEDERAL) 9 PPM 8-HR / 35 PPM 1-HR

PARAMETER . . CARBON MONOXIDE
AREA. . . . . 1100, MISSOULA COUNTY
SITE. . . . . 024, BOYD PARK
CITY. . . . . MISSOULA

MONTANA STATE AIR QUALITY BUREAU

JUNE 18, 1984 TECHNICAL SERVICES

3. Table 39 summarizes the carbon monoxide data for 1984 in Missoula. The Malfunction Junction SE site did not operate during 1984. The Boyd Park site recorded two exceedances of the 9 ppm eight-hour standard. The exceedances occurred back to back on January 5 and 6. Although the average concentrations during both exceedances were about 10 ppm, a 13.3 ppm eight-hour average can be calculated by choosing the worst part of the episode.

4. The Missoula County Health Department temporarily shut down the Malfunction Junction carbon monoxide site in July, 1983. This site will

be reactivated after the completion of the construction project at the intersection of Russell, South and Highway 93. The site will probably open in the fall of 1985. The department and Missoula County consider the long-range operation of this site to be essential for several reasons: (1) the very high concentrations observed there; (2) the site's significance in regard to nonattainment designation and tracking; and (3) the large amount of historical data.

5. The Missoula County Health Department operates a carbon monoxide monitor at Boyd Park in the southern part of the city (see Figure 23). The site is located in a residential area which is almost entirely free of traffic influence. However, this part of the city has a very high use of wood for residential heating and recreation. The department and Missoula County are convinced that wood burning is the major cause of high carbon monoxide concentrations at this site. However, this conclusion is somewhat undermined by the fact that typical 8:00 a.m. and 5:00 p.m. traffic peaks appear on the Boyd Park diurnal plot (Figure 70).

   The department recommends that this site continue to be operated. To save money, Missoula County intends to run the site only during the winter. They suggest that high readings are nonexistent in the summer and that the CO standard is a short-term standard. If personnel become available, year-round monitoring will be resumed.

Libby

1. Libby is a small town in northwestern Montana which has very poor atmospheric dispersion and an extremely high usage of wood for home heating. In light of Libby's extremely high total suspended particulate levels and the high carbon monoxide concentrations observed in residential areas

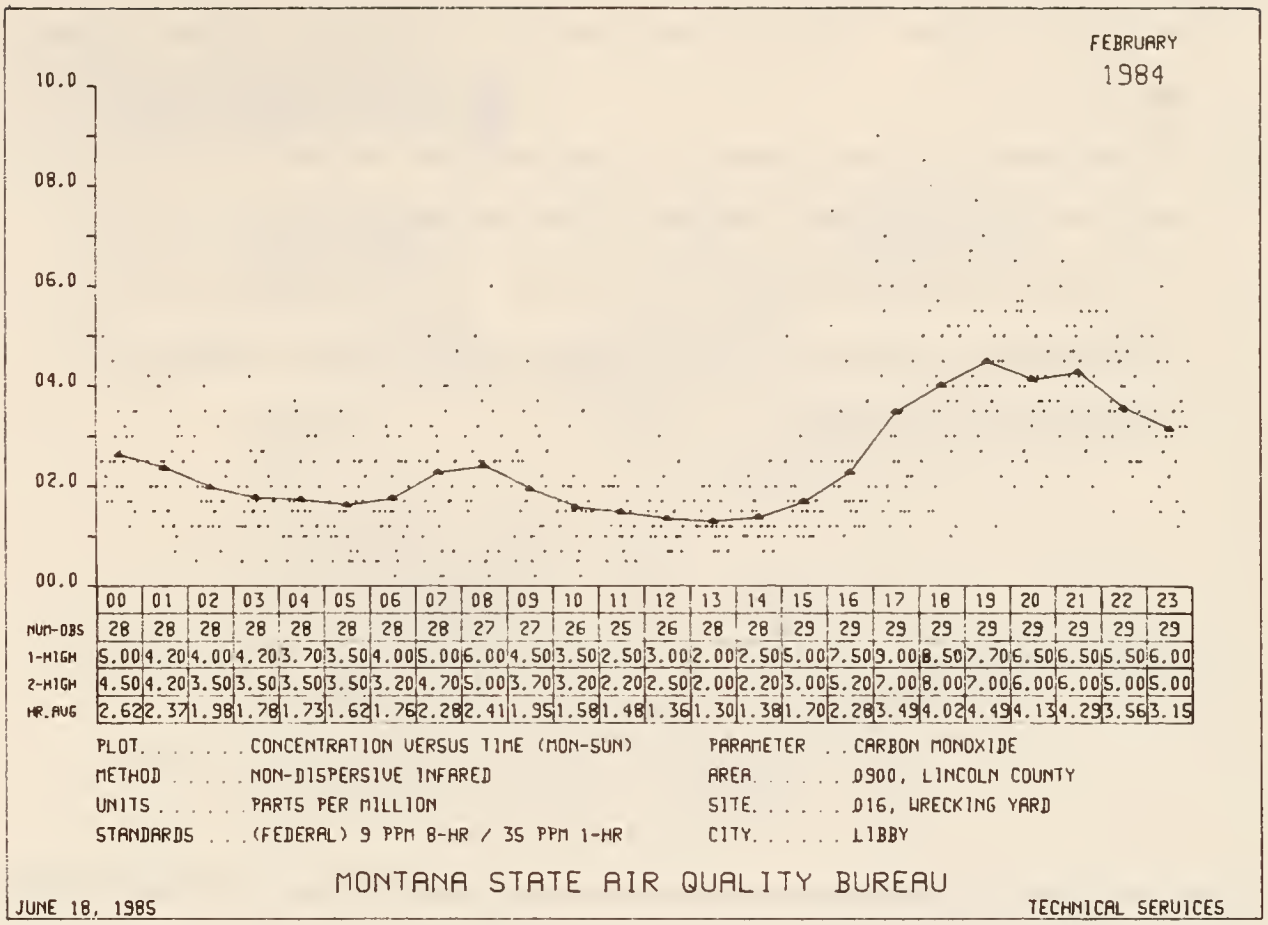
of Missoula, the department recommended in the 1983 Network Review that carbon monoxide monitoring be initiated in Libby.

2. The department installed a carbon monoxide analyzer at the Wrecking Yard site (see Figure 10) during January, 1984. The site is located in the County impoundment yard across from the Lincoln County Courthouse in downtown Libby. The department calibrated and maintained the site and contracted County personnel to perform the daily checks. The department operated the site from the end of January to the middle of March.

3. During the sampling period, moderately high carbon monoxide concentrations were observed (see Table 39). The department did not expect high readings since Libby is a small town (pop. 2800) with relatively low traffic volumes. On the other hand, the department was interested in determining the impact of intensive residential wood burning. The highest one-hour concentration was 9.0 ppm and the highest eight-hour average was 6.7 ppm. Both readings occurred between 4:00 and 11:00 p.m. on February 3. Since funding was critical, the department chose to operate the site only during the winter when carbon monoxide concentrations are usually the highest.

4. Figure 71 is a diurnal plot of carbon monoxide concentrations at the Libby Wrecking Yard site. The diurnal plot has the typical 8:00 a.m. and 5:00 p.m. peaks usually associated with automobile tailpipe emissions. Although tailpipe emissions are probably a significant source of carbon monoxide in Libby, the department also suspects emissions from residential wood stoves. Most homeowners refuel their stoves when they get up in the morning, when they get home from work, and before they go to bed. During each of these time periods, carbon monoxide concentrations are higher. Note that the first two periods also coincide with

FIGURE 71



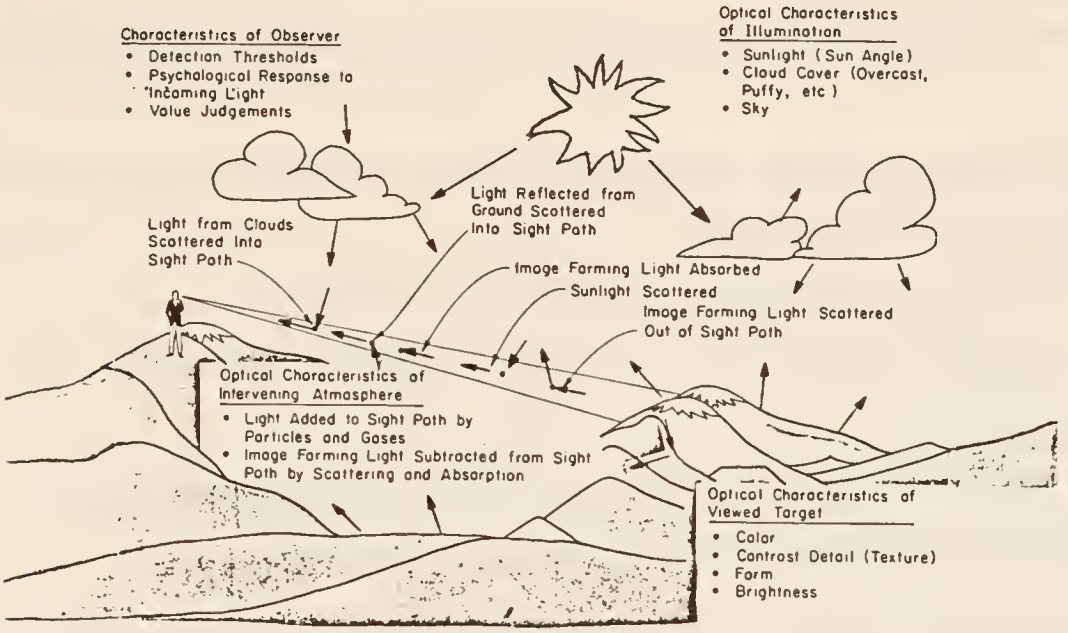
peak automobile traffic, making it difficult to differentiate between the two sources.

5. The department performed a linear regression analysis to compare hourly carbon monoxide data with hourly back-scatter data. The analysis was performed on data gathered at the Wrecking Yard site during February and March, 1984. The correlation coefficient was 0.621 and was statistically significant at the 95 percent probability level. The department believes these results indicate that the sources of carbon monoxide and fine

particulate are the same or that meteorological conditions tend to control the concentrations. The department suspects that both hypotheses are partially true.

6. The department will not operate a carbon monoxide analyzer in Libby for at least two years. Although concentrations were moderate, no violations were observed and funding is not available. In two or three years, the department may re-establish carbon monoxide monitoring to determine if concentrations have changed.

Visibility


Characteristics of Observer
• Detection Thresholds
• Psychological Response to Incoming Light
• Value Judgements
Optical Characteristics of Illumination
• Sunlight (Sun Angle)
• Cloud Cover (Overcast, Puffy, etc.)
• Sky
Light Reflected from Ground Scattered Into Sight Path
Light from Clouds Scattered Into Sight Path
Image Forming Light Absorbed
Sunlight Scattered
Image Forming Light Scattered Out of Sight Path
Optical Characteristics of Intervening Atmosphere
• Light Added to Sight Path by Particles and Gases
• Image Forming Light Subtracted from Sight Path by Scattering and Absorption
Optical Characteristics of Viewed Target
• Color
• Contrast Detail (Texture)
• Form
• Brightness

Federal regulations require Montana to protect visibility in Prevention of Significant Deterioration (PSD) Class I areas. The State of Montana also believes it has a responsibility to protect vistas throughout the state.

Visibility degradation is caused by the light scattering and absorbing effect of fine particulates and certain visible gases such as oxides of nitrogen. In Montana, visibility impairment is usually caused by fine particulates, since Montana does not have a lot of heavy industry or automobile traffic.

In July, 1985, the Board of Health and Environmental Sciences adopted visibility regulations for new major stationary sources and approved revisions to the Montana SIP which contained these regulations as well as a visibility

monitoring plan. The monitoring plan calls for an annual review of the needs for visibility monitoring, analysis of existing data, and requirements for new facilities to supply monitoring data when their emissions may be expected to impact a Class I area.

The department has identified four major objectives of the monitoring plan:

1. To determine existing impairment, if any, in mandatory Class I areas and the sources of impairment;
2. To provide information for new source impact analyses;
3. To determine actual effects on visibility from the operation of new sources; and
4. To establish visibility trends in order to evaluate progress toward meeting the national goal of visibility protection.

The department will carry out the four objectives above by implementing the following program elements:

1. The department will address and consider the need for visibility monitoring as an integral part of its annual Network Review report. The Federal Land Managers (FLM) will be given an opportunity to comment on the annual Network Review before it becomes final.
2. In accordance with the results of the Network Review, the department will sponsor visibility stations and may enter into an agreement with the FLM to operate such stations by either party and to share data.
3. The department will request from each FLM responsible for any Class I area copies of any and all past or existing programs designed to monitor or evaluate visibility.

4. The department will request copies of all future visibility data gathered by each FLM on an annual basis, including any analysis and interpretation of such data.
5. The department will evaluate the data supplied by the FLM in addition to any other data collected by the department or any other appropriate source (such as proposed major stationary sources) on an annual basis.

Since the 1985 Network Review was substantially completed prior to the July 1985 Board of Health action, the department was unable to request and review any additional visibility data from the Federal Land Managers. However, the department did submit the draft 1985 Network Review to the Montana Federal Land Managers for their review. Comments were received from the U.S. Forest Service and incorporated into this document.

The department is aware that visibility monitoring is being conducted in Glacier National Park, Yellowstone National Park, and at the Fort Peck Indian Reservation. The department considered the locations of these monitoring sites during the preparation of this report.

Libby

1. The department and the Lincoln County Health Department operated a nephelometer at two locations in Libby during 1984. The sampler was located at the Wrecking Yard site from January through March and at the River site from September through November (see Figure 10). The department chose the Wrecking Yard site as an area likely to exhibit a very high fine particulate concentration. The department anticipated that wood smoke and automobile exhaust would both be very high in this area. The River site was operated as part of the fall Smoke Management Program. The Smoke Management Monitoring Team used the nephelometer data to quantify existing

air quality and to determine if air quality was improving or declining. The team used this information as one part of the decision-making process in regard to issuing open burning restrictions on slash burning.

2. During 1984, the highest one-hour and twenty-four hour back-scattering coefficients were recorded at the Wrecking Yard site. The one-hour maximum of 93.1 x 10^{-5} per meter is the maximum reading the instrument was capable of measuring. In fact, during February, over twelve percent of the 672 hourly values were beyond the range of the instrument. Most of these high values occurred between 8:00 p.m. and 4:00 a.m. The mean back-scattering coefficient was 45.5 at the Wrecking Yard and 18.1 at the River site. These numbers are not comparable, however, since the sampling was conducted at different times of the year. Table 40 summarizes all of the back-scattering data.

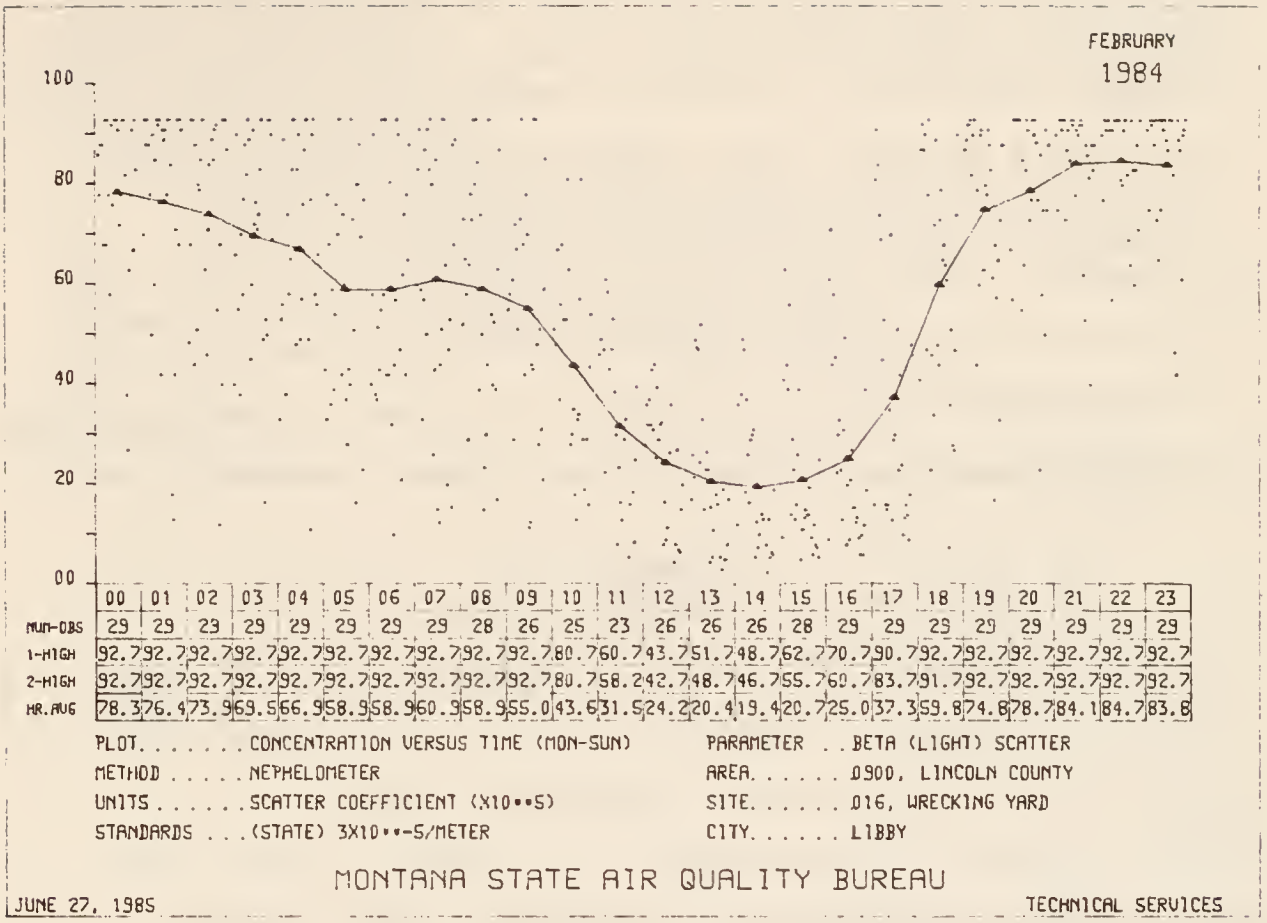
TABLE 40

SUMMARY OF 1984 BACK-SCATTERING DATA FROM LIBBY

Site	Month	No. of Observations	1-hour Max.	24-hour Max.	Monthly Average
Wrecking Yard	Jan.	725	93.1	80.6	44.9
	Feb.	672	92.7	75.6	56.9
	Mar.	732	92.7	59.7	35.7
River Site	Sep.	578	68.5	33.6	11.9
	Oct.	717	80.5	45.4	16.4
	Nov.	698	81.5	49.3	24.9

3. The Wrecking Yard site is located in downtown Libby. Figure 72 is a diurnal plot of the back-scattering data for February, 1984. The visibility at the Wrecking Yard is the best during mid-afternoon when atmospheric dispersion is also at its best. After 5:00 p.m., visibility rapidly declines until it stabilizes between 9:00 p.m. and midnight. The

FIGURE 72

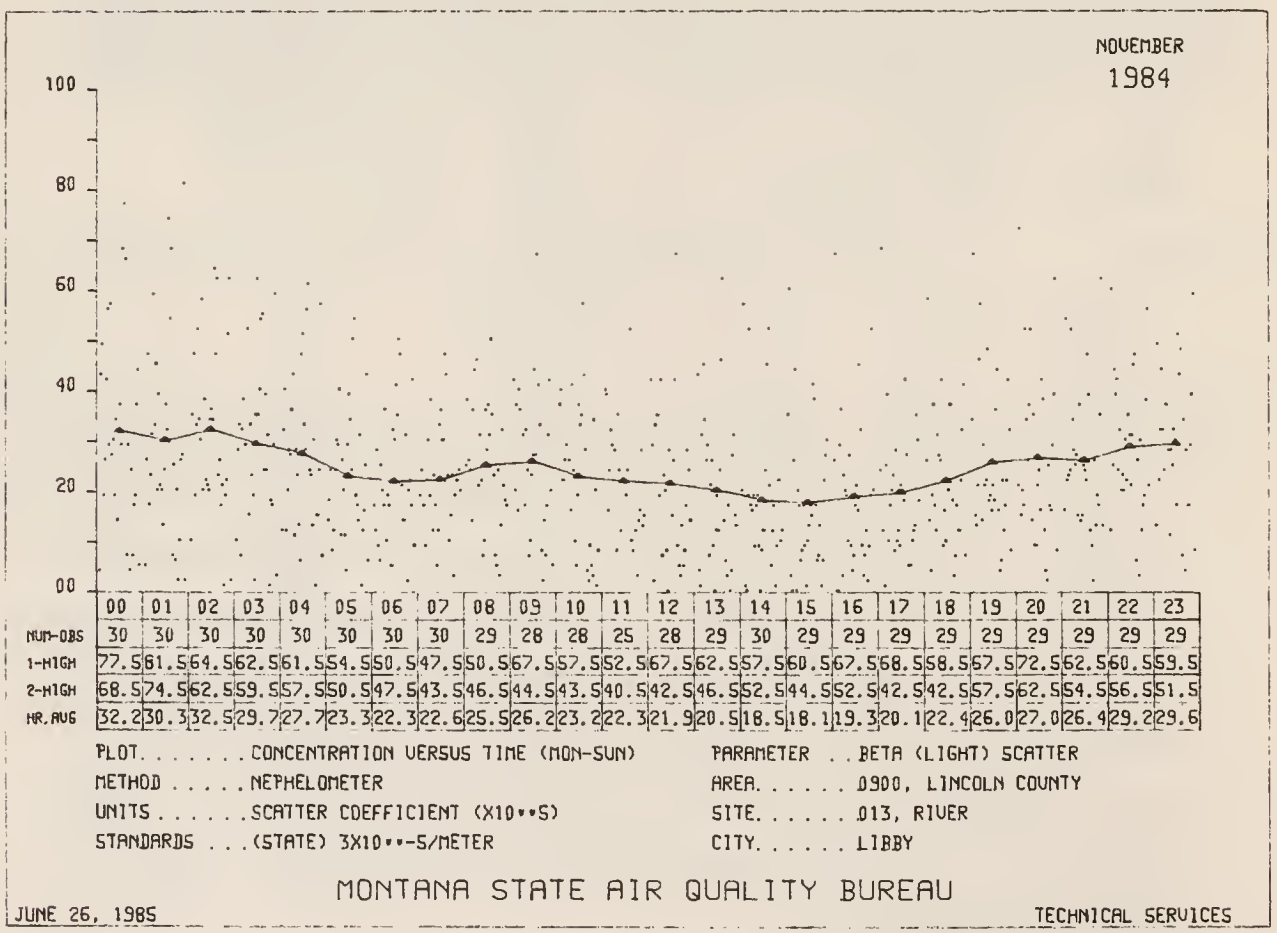


department suspects that the 5:00 p.m. decline in visibility is caused by increased vehicle traffic and homeowners stoking up their wood stoves after work. From midnight until mid-afternoon, the visibility gradually improves with a slight reversal at 7:00-8:00 a.m. The gradual improvement is probably due to lower emissions after midnight when human activity is very low and wood stoves are allowed to burn down. About 7:00 a.m., people recharge their stoves before going to work and visibility declines temporarily. As the ventilation improves during the daylight hours, visibility also improves.

4. The River site is located across the Kootenai River approximately 0.3 mile north of the central business district. The departments' objective for monitoring at this location was to measure areawide visibility and not specifically the city of Libby. However, fine particulate emissions from the city and the St. Regis mill no doubt impact this site.

5. Figure 73 is a diurnal plot of back-scattering data from the River site. The plot is substantially different from the plot for the Wrecking Yard. The department believes the differences are the result of sampling during different seasons and that the River site actually is monitoring areawide

FIGURE 73



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	29	28	28	25	28	29	30	29	29	29	29	29	29	29	29	29
1-HIGH	77.5	61.5	64.5	62.5	61.5	54.5	50.5	47.5	50.5	67.5	57.5	52.5	67.5	62.5	57.5	60.5	67.5	68.5	58.5	67.5	72.5	62.5	60.5	59.5
2-HIGH	68.5	74.5	62.5	59.5	57.5	50.5	47.5	43.5	46.5	44.5	43.5	40.5	42.5	46.5	52.5	44.5	52.5	42.5	42.5	57.5	62.5	54.5	56.5	51.5
HR.AVG	32.2	30.3	32.5	29.7	27.7	23.3	22.3	22.6	25.5	26.2	23.2	22.3	21.9	20.5	18.5	18.1	19.3	20.1	22.4	26.0	27.0	26.4	29.2	29.6

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . NEPHELOMETER
UNITS . . . . . SCATTER COEFFICIENT (X10**S)
STANDARDS . . . (STATE) 3X10**-S/METER

PARAMETER . . BETA (LIGHT) SCATTER
AREA. . . . . 0900, LINCOLN COUNTY
SITE. . . . . 013, RIVER
CITY. . . . . LIBBY

MONTANA STATE AIR QUALITY BUREAU

JUNE 26, 1985 TECHNICAL SERVICES

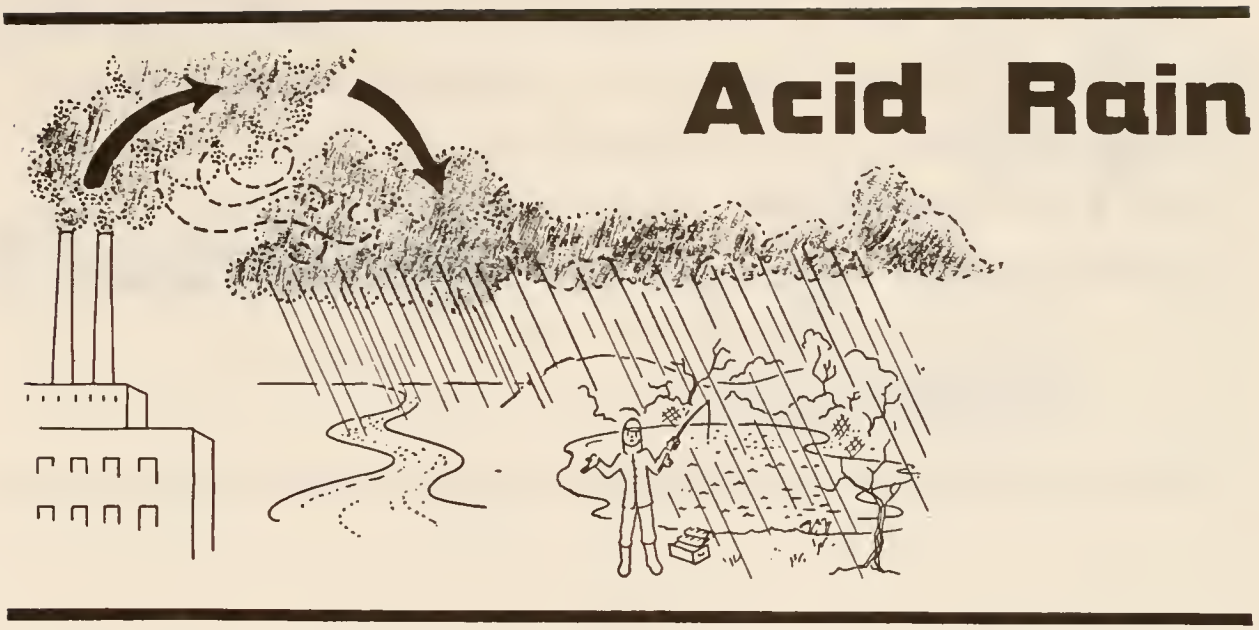
visibility. Although the best visibility occurs during mid-afternoon, there is very little hour-to-hour variation. The back-scattering coefficients for the River site were much lower than the Wrecking Yard site, but were still quite high.

6. The department, with the help of the Lincoln County Health Department, will continue to operate this site during the fall season. The site is extremely valuable to the Smoke Management Program.

Prospective Sites

1. The department purchased two used telephotometers during early 1985. The department would like to establish a visibility monitoring site near a Class I area. The site would be equipped with a telephotometer, nephelometer, fine particulate monitor, and acid deposition sampler.
2. The department is unsure if sufficient funding is available to operate such a site. Although the department is considering several different Class I areas, the Gates of the Mountains Wilderness area would be a very good location. Access to the edge of the wilderness is relatively good at the Beartooth Ranch, the boat landing area, and Nelson. In addition, the area is close to Helena (15-40 miles), so that it could be serviced quite easily.

   The U.S. Forest Service recommended the Anaconda Pintlar Wilderness and the Gates of the Mountains Wilderness as the two Class I areas most likely to be impacted by new industrial development. On the other hand, the Forest Service would like to see visibility monitoring conducted in or near the nation's premier wilderness, the Bob Marshall. The department intends to evaluate possible sites in or near each of these areas and, if funding is available, locate a site in the best area.



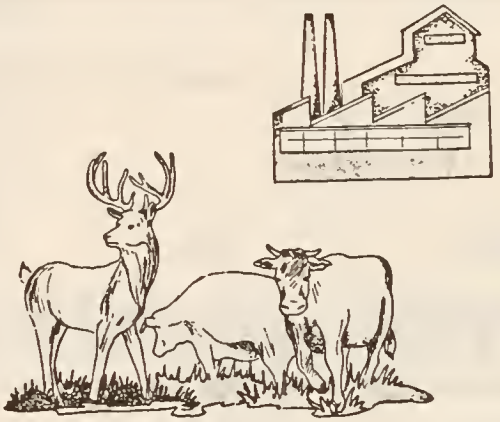
The department currently is not monitoring acid deposition. In early 1985, the department purchased five used acid deposition monitors. The samplers are capable of sampling both wet and dry deposition.

The Federal Land Managers who are in charge of many of the high elevation lakes and streams which are considered sensitive to acid deposition are extremely interested in expanding acid deposition monitoring. The department shares their interest, but is limited in the amount of monitoring it can do by budget restraints. However, the department proposes to operate one sampler at the proposed visibility site and to loan samplers to any government entity willing to operate and maintain a sampler, as well as analyze the samples and sumarize the data.

The department intends to locate its acid deposition sampler at the proposed visibility site for convenience and because the siting requirements for visibility monitoring and acid deposition monitoring can be met at one location. The department is aware that acid deposition monitoring is

currently being performed in Glacier National Park, Yellowstone National Park, and on the Fort Peck Indian Reservation. The department will consider the geographic distribution of these monitoring sites when choosing a final visibility/acid deposition site. The department will also consider the buffering capacity of the soils in each area before making a final selection.

Fluorides



During 1981, the Montana Board of Health and Environmental Sciences adopted new ambient standards for fluorides. The standards are based on the concentration of fluoride in forage. The standards were set at 50 ppm for a monthly average and 35 ppm for a grazing season average.

The department is auditing vegetation sampling conducted by the Stauffer Chemical Company and the ARCO aluminum plant to determine compliance. In addition, the department receives sample splits from both companies and analyzes them in the department's laboratory. Table 41 summarizes the 1984 fluoride data from Ramsay and Columbia Falls.

In an attempt to better define "grazing season", the Stauffer Chemical Company, in cooperation with the department, has selected an additional sampling plot to gather a sample for a digestible energy analysis. The results of this analysis will assist in determining whether the livestock are obtaining their minimum nutritional needs.

TABLE 41

1984 FLUORIDE IN VEGETATION DATA
(ug/g)

Area	Site	Highest Monthly Average	Grazing Season Average
Columbia Falls	Liddle	45.5	18.6
	Hoffman	17.0	8.8
	Doane	57.5	19.3
Ramsay	Ueland #3	27.0	--
	Hilderman #6	133.5	47.9
	Tamietti #7	46.5	24.0
	Craddock #16	93.5	39.1

Prioritization of Proposed Network Modifications

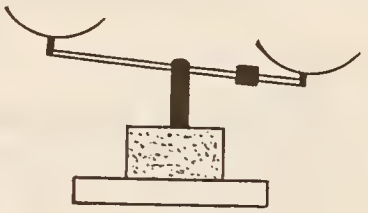


Table 42 presents a prioritized list of proposed modifications to the Montana ambient air monitoring network. The department prioritized this list based on the importance of the changes and the financial costs involved. It is the department's policy to operate the existing network correctly before initiating new projects; therefore, many quality assurance items are prioritized quite high.

The department will initiate the proposed modifications starting with item number 1 and proceeding through item number 64 as manpower and money are available. However, the first group of modifications will be completed before each subsequent group is started. Many of the items listed in Table 42 have already been completed and are identified accordingly.

TABLE 42

LIST OF PROPOSED MODIFICATIONS TO THE MONTANA
AMBIENT MONITORING NETWORK

*1. Terminate the Eastern Montana TSP background site at Jordan.
*2. Upgrade the electricity supply at the Bozeman East Main City Building site.
*3. Install a TSP site in the Sourdough Creek area of Bozeman.
*4. Turn over the Taft School TSP site to Yellowstone County.
*5. Shut down the Scobey monitoring sites except for sulfation rate.
*6. Shut down TSP monitoring at Plevna and Malta.
*7. Install collocated PM-10 monitors at the Lincoln County Courthouse site in Libby.
*8. Install two PM-10 monitors at the Rose Park and Boyd Park sites in Missoula.
*9. Install a PM-10 monitor at the East Main City Building site in Bozeman.
*10. Install a PM-10 monitor at the Greeley School site in Butte.
*11. Install collocated PM-10 monitors at the Cogswell Building site in Helena.
*12. Install a PM-10 monitor at Phillips Lane in the Helena valley.
*13. Install a PM-10 monitor at the Junior High School site in Columbia Falls.
*14. Install a PM-10 monitor at the Universal Athletics site in Kalispell.
*15. Install a PM-10 monitor at the Sanders County Courthouse site in Thompson Falls.
*16. Install a PM-10 monitor at the Ovando background site.
*17. Install a tribal PM-10 monitor at the Saddle Shop in Polson.
*18. Terminate lead monitoring at the Lincoln School and Highway Junction sites in Anaconda.
*19. Shut down the South site in East Helena.
*20. Terminate all trace metal analysis except for lead at all the East Helena sites except for the Firehall site where copper and zinc will also be monitored.
*21. Terminate all trace metal analysis at the Sanders County Courthouse site in Thompson Falls.
*22. Modify the Sidney sulfation plate network.
*23. Terminate sulfate analysis at the Courthouse East site in Kalispell.
*24. Permanently terminate carbon monoxide monitoring in Libby.
*25. Permanently eliminate the Libby Wrecking Yard site.
*26. Terminate all nitrate analysis on high volume sampler filters except for the Glacier National Park sites.
*27. Terminate TSP monitoring at the Medical Arts Building in Glendive.
*28. Install a PM-10 monitor at the Downtown site in Great Falls.
*29. Terminate TSP monitoring at the Whittier School in Bozeman.
*30. Install a TSP site at the Christie Fields site in Bozeman.
*31. Terminate collocated TSP monitoring at the Taft School in Billings.

32. Install a PM-10 monitor at the City Hall site in Billings.
33. Install a PM-10 monitor at the Health Department Building in Missoula.
34. Terminate TSP monitoring at the Spurgin and Tower site in Missoula.

* Already accomplished.

35. Perform a CMB Study in Kalispell.
36. Install a TSP site in West Billings at the Meadowlark or Arrowhead Schools.
37. Redesignate the Taft School TSP site in Billings from NAMS to SLAMS on 1/1/86.
38. Redesignate the City Hall TSP site in Billings from SLAMS to NAMS on 1/1/86.
39. Operate a nephelometer at the River site in Libby during the fall for smoke management.

40. Terminate TSP monitoring at the present Grand Avenue School site in Billings.
41. Shut down the Taft School site in Billings and move it to the track at the Grand Avenue School.
42. Install a TSP monitor in the Lower Rattlesnake in Missoula.
43. Study the possibility of designating Boyd Park as the Missoula emergency episode site.
44. Install a TSP monitor in East Missoula.
45. Perform a very simple source apportionment study at the Montana City School site.
46. Install a PM-10 monitor at the Firehall site in East Helena.

47. Start carbon monoxide monitoring at the Malfunction Junction site in Missoula as soon as the road construction is complete.
48. Install a TSP monitor in southeast Great Falls.
49. Terminate TSP monitoring at the Brown Residence in Libby.
50. Move the Cooney Home site in Helena to a new valley site.
51. Install a TSP monitor in Superior.
52. Move the Anders Residence TSP monitor to the Junior High School in Columbia Falls.
53. Install a visibility site at a Class I area near Helena and equip the site with: acid deposition sampler, telephotometer, nephelometer, and PM-10 sampler.
54. Terminate all sampling at the Hastie Residence site in East Helena.
55. Insulate all the monitoring trailers that are in use.
56. Install a PM-10 monitor in Hamilton.
57. Loan any unused acid deposition samplers to any government agency which will utilize them.
58. Install a TSP monitor in West Yellowstone.
59. Install a TSP monitor in Livingston.

60. Install a carbon monoxide monitor in Helena.
61. Analyze for lead, arsenic, copper, zinc, and cadmium at the Firehall site in East Helena.
62. Install a sulfur dioxide site in Sidney.
63. Install a TSP monitor at Terry Park in Billings.
64. Install a carbon monoxide monitor during the winter in Libby.

Rationale For Site Designation

The department's stations are designated either NAMS, SLAMS or SPM, depending on the general purpose of the station and the period of time it is expected to operate. Table 43 describes the distinction between each type of site.

In general, NAMS and SLAMS are intended to operate for long periods of time. Stations established for short-term measurements are normally designated SPM. If it is later decided to maintain the station beyond its originally projected closing date, the station could be redesignated SLAMS.

Table 44 lists the department's NAMS, SLAMS and SPM stations, their projected closing dates, and the reasons for their operation.

TABLE 43

MAJOR STATION DESCRIPTIONS AND COMPARISONS

Monitoring Station	SLAMS	NAMS	SPM
Purpose	General program monitoring for criteria pollutants. Supplies data for state implementation plan (SIP). Used for emergency episode monitoring.	Sets national policy, obtains long-term trend data, is used in special national studies, and is selected to monitor highest pollution areas which also have high population.	Special and short-term monitoring accordi ng to Montana needs. Monitors non-criteria pollutants.
Installation Deadline	January 1, 1983	January 1, 1981	None
Review Frequency	Annual	Every third year	Annual
Relocation Frequency	Relocated or changed only on annual basis if necessary and with EPA approval.	Not to be moved without prior EPA approval	No restrictions
Data Reporting	Beginning in 1981, annual reports due by July 1st of the following year to EPA Region and headquarters in N. Carolina.	Same	No reports due unless data is used for SIP purposes.
Report Requirements	Detailed summary, including violations of standards.	Same	None

TABLE 44

STATE OF MONTANA, AIR QUALITY BUREAU
AIR MONITORING NETWORK

Station		SAROAD Site I.D.	Monitoring Objectives	Spatial Scale	Target Date New station to open	Target Date Existing station to close
I. Total Suspended Particulates (TSP)						
A. National Air Monitoring Stations (NAMS)						
Billings	Taft School	27 0080 062 F01	H,P,S	N		9/85
	Taft School (collocated)	27 0080 062 F07	H,P,S	N		8/85
	*City Hall	27 0080 008 G01	H,P	N	1/86	
	*City Hall (collocated)	27 0080 008 G07	H,P	N	1/86	
Great Falls	Downtown	27 0660 017 G01	H,P	N		
	Downtown (co-located)	27 0660 017 G07	H,P	N		
* redesignation to NAMS site on 1/86						
B. State and Local Air Monitoring stations (SLAMS)						
Anaconda	Lincoln School	27 0020 007 F01	P	N		
	Highway Junction	27 0400 004 F02	S	N		
Billings	Sandstone School	27 0080 067 G01	P	N		
	City Hall	27 0080 008 G01	H,P	N		9/85
	City Hall (coll)	27 0080 028 G07	H,P	N		9/85
	Grand Ave. Sch.	27 0080 009 G01	H,P	N		9/85
	Grand Ave. Sch. Track		H,P	N	9/85	
	Lockwood Park	27 0080 065 F01	P,S	N		

Bozeman	East Main City Building	27 0120 002 F01	H,P	N		
Butte	Greeley School	27 0160 005 F01	H,P,S	N		
Columbia Falls	Anders Residence	27 0270 005 F01	H,P	N		10/85
	Junior High Sch.	27 0270 003 F01	H,P	N	10/85	
East Helena	Hastie Residence	27 0860 002 F02	H,P,S	N		1/86
	Hadfield	27 0860 719 F02	H,P,S	N		
	Hadfield (co-located)	27 0860 719 F07	H,P,S	N		
	Dartman Field	27 0860 724 F02	H,S	N		
	Firehall	27 0860 714 F02	H,P,S	N		
Eureka	*Lincoln Elec. Coop	27 0940 005 F01	H,P	N		
Great Falls	Black Eagle P.O.	27 0660 019 G01	H,P,S	N		
	Fire Station	27 0660 009 G01	H,P	N		
Hamilton	*Ravalli Co Crths.	27 1300 001 F01	H,P	N		
Helena	Cogswell Bldg.	27 0720 001 F01	P	N		
	Capital Courts	27 0720 013 G05	P	N		
	Cooney Home	27 0720 016 G05	P	N		9/85
	Helena Valley		H,P	N	9/85	
Kalispell	Universal Ath.	27 0800 015 F01	H,P	N		
Laurel	*Junior High Sch.	27 0840 001 G02	P	N		
Libby	Brown Residence	27 0900 010 F01	P,S	N		9/85
	Courthouse Roof	27 0900 012 F01	H,P	N		
	Courthouse Roof (co-located)	27 0900 012 F07	H,P	N		
Missoula	Rose Park	27 1100 020 G01	H,P	N		
	Boyd Park	27 1100 024 G02	H,P	N		
	*Env. Health Bldg.	27 1100 030 G01	H,P	N		
	*Meadow Hill Sch.	27 1100 029 F05	P	N		

Ovando	Terry Smith Ranch	27 1260 024 F03	B	R	
Sidney	*City Hall	27 1320 010 F01	H,P	N	
Thompson Falls	*Sanders Co. Crths	27 1400 003 F05	H,P	N	

*Redesignate to SLAMS on 1/86

C. Special Purpose Monitors (SPM)

Billings	Terry Park		H,P	N	6/86
	West Billings/Com		H	N	6/86
Bozeman	Sourdough Creek	27 0120 007 F01	H,P	N	7/85
Choteau	Circle 8 Guest Ranch	27 1560 004 N05	B	R	
Deer Lodge	Powell Co.Cths.	27 0380 001 F01	H,P	N	
Dillon	Beaver.Co.Cths.	27 0420 001 F01	H,P	N	
Glacier N.P.	St. Marys	27 0570 010 F02	B	R	
	W. Glacier	27 0570 007 F02	B	R	
Great Falls	Southeast		P	N	10/85
Kalispell	West Kalispell		P	N	10/85
Livingston	City Center		H,P	N	
Missoula	Hoerner-Waldorf #1	27 1100 015 G02	S	N	
	Hoerner-Waldorf #1 collocated	27 1100 015 G07	S	N	
	Hoerner-Waldorf #2	27 1100 016 G02	S	N	
	Rattlesnake		H,P	N	10/85
	East Missoula		P	N	10/85

Missoula	Spurgin Tower	27 1100 030 G01	P	N		9/85
Montana City	School	27 0760 905 F05	P	N		
Scobey	Hanrahan	27 0340 004 F03	B	R	7/87	6/85
Superior	Downtown		H,P	N	5/86	
West Yellowstone	City Center		H,P	N	6/86	

II. Particulate Matter Ten Micron (PM-10)

A. Special Purpose Monitors (SPM)

Billings	City Hall	27 0080 008 G01	H,P	N	10/85
Bozeman	E Main City Bldg	27 0120 002 F01	H,P	N	
Butte	Greeley School	27 0160 005 F01	H,P	N	
Columbia Falls	Junior High Sch.	27 0270 003 F01	H,P	N	
East Helena	Firehall	27 0860 714 F02	H,P,S	N	10/85
Great Falls	Downtown	27 0660 017 G01	H,P	N	10/85
Hamilton	Ravalli Co Crths	27 1300 001 F01	H,P	N	10/85
Helena	Cogswell Bldg.	27 0720 001 F01	H,P	N	
	Cogswell Bldg. (collocated)	27 0720 001 F07	H,P	N	
	Phillips Lane	27 0860 009 F01	H,P	N	
Kalispell	Universal Ath.	27 0800 015 F01	H,P	N	
Libby	Lincoln Co Crths	27 0900 012 F01	H,P	N	
	Lincoln Co Crths (collocated)	27 0900 012 F07	H,P	N	
Missoula	Rose Park	27 1100 020 G01	H,P	N	
	Boyd Park	27 1100 024 G01	H,P	N	
	Meadow Hills Sch.	27 1100 030 G01	P	N	5/86
	Env. Health Bldg.	27 1100 029 G01	H,P	N	5/86
Ovando	Smith Ranch	27 1260 024 F03	B	R	
Thompson Falls	Sanders Co. Crths	27 1400 003 F05	H,P	N	

III. LEAD (Pb)

A. State and Local Air Monitoring Stations (SLAMS)

East Helena	Hadfield	27 0860 719 F02	H,S,P	Mi		
	Hadfield (co-located)	27 0860 719 F07	H,S,P	Mi		
	Hastie	27 0860 002 F02	H,S,P	M		1/86
	Dartman	27 0860 722 F02	H,S	N		
	Firehall	27 0860 714 F02	H,S,P	Mi		

B. Special Purpose Monitors (SPM)

Montana City	School	27 0760 905 F05	P	N		

IV. SULFUR DIOXIDE (SO2)

A. National Air Monitoring Stations (NAMS)

Billings	Lockwood Park	27 0080 065 F01	S,P	N		

B. State and Local Air Monitoring stations (SLAMS)

Billings	Coburn Road	27 0080 066 F01	S	N		
	No. Johnson	27 0080 064 F01	S	N		
Scobey	Hanrahan	27 0340 004 F03	S	R	7/87	

V. CARBON MONOXIDE (CO)

A. State and Local Air Monitoring stations (SLAMS)

Billings	Fairgrounds	27 0080 061 F02	H,P,S	M		
Great Falls	Pardis	27 0660 023 G02	H,P,S	M		
Missoula	Boyd Park	27 1100 024 G02	P	N		
	Malfunction Jct Southeast	27 1080 005 F01	H,P,S	M	10/85	

B. Special Purpose Monitors (SPM)

Missoula	Residential	P	N	6/87
Billings	Grand Ave. Sch. Track	H,P,S	M	6/87
Helena	Last Chance	H,P,S	M	6/87

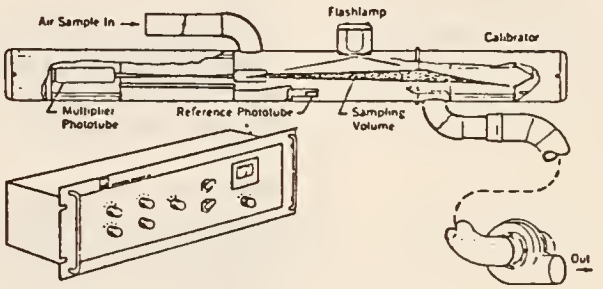
Monitoring Objectives:

H Highest Concentration
P Population
S Source
B Background

Spatial Scales:

Mi Micro
M Middle
N Neighborhood
U Urban
R Regional

Sampling Methods & Siting Criteria



The department uses EPA reference or equivalent methods for all air monitoring of criteria pollutants. For other pollutants, the department uses department-specified methods. Table 45 summarizes the various sampling methods used by the department.

The department also follows all federal requirements in regard to siting criteria. Table 46 summarizes the various siting requirements.

TABLE 45

SAMPLING AND ANALYSIS METHODS

Parameter	Sampling Method	Analysis Method
TSP	High Volume Method, 40 CFR, Part 50, App. B	Gravimetric
PM (2.5 and 15)	Dichotomous Virtual Impactor, Section 2.4.5 Montana Quality Assurance Manual, Sierra Instruments, Model 244	Gravimetric
	Beta Attenuation, Section 2.4.6 Montana Quality Assurance Manual, GCA Corporation, Aerosol Mass Monitor, Model APM	
	High Volume Method, 40 CFR, Part 50, App. B, High Volume Sampler with PM-15 Size Selective Inlet	Gravimetric
PM-10	Federal Register, March 20, 1984, 40 CFR, Part 50, 53, and 58, High Volume Sampler with PM-10 Size Selective Inlet	Gravimetric
	Beta Attenuation, Dasibi Model MPSI 100	
Lead	High Volume Method, 40 CFR, Part 50, App. B	Emission Spectra-ICAP
Trace Metals	High Volume Method, 40 CFR, Part 50, App. B	Emission Spectra-ICAP
Sulfates	High Volume Method, 40 CFR, Part 50, App. B	Colorimetric
Nitrates	High Volume Method, 40 CFR, Part 50, App. B	Reduction-Diazo Coupling
Sulfur Dioxide	EQSA-0276-009 "Thermo Electron Model 43 Pulse Fluorescent Sulfur Dioxide Analyzer"	
Carbon Monoxide	RFCA-0276-008 "Bendix Model 8501-5CA Infrared CO Analyzer"	
	RFCA-0381-051 "Dasibi Model 3003 Gas Filter Correlation CO Analyzer"	

Parameter	Sampling Method	Analysis Method
Ozone	EQOA-0577-019 "Dasibi Model 1003-AH, 1003-PC, or 1003-RS Ozone Analyzers"	
Nitrogen Dioxide	RFNA-0677-021 "Monitor Labs Model 8440E Nitrogen Oxides Analyzer"	
Sulfation Rate	Method 42410-02-71T, Tentative Method of Analysis of the Sulfation Rate of the Atmosphere (Lead Plate Method), Methods of Air Sampling and Analysis, Second Edition	Turbidimetric
Visibility	Method 1120-03-76T, Tentative Method of Analysis for Suspended Particulate in the Atmosphere (Integrating Nephelometer) Methods of Air Sampling and Analysis, Second Edition, Meteorology Research, Inc., Model 1550B Contrast Telephotometry, Meteorology Research Inc., Vista Ranger, Model 3030	
Acid Deposition	ASTM Method ASTM STP 823, Sampling, Analysis, and Quality Assurance Protocols for National Atmosphere Deposition Program, Sampling and Analysis of Rain	Depends on what analyses are performed
Fluorides	Fluorides in Forage, ARM 16.8.813, Vegetation Sampling	Specific Ion Electrode

TABLE 46

SUMMARY OF PROBE SITING CRITERIA

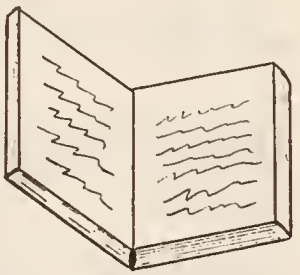
Pollutant	Scale	Height Above Ground, Meters	Distance from Supporting Structure in Meters Vert.	Horiz.	Other Spacing Criteria
TSP	All	2-15	--	2	1. Must be >20 meters from dripline of trees. 2. Distance from sampler to obstacle must be at least twice the height the obstacle protrudes above the sampler. 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby. 5. Must have minimum spacing from roads. This varies with height of monitor and spatial scale.
SO_2	All	3-15	1	1	1. Must be >20 meters from dripline of trees. 2. Distance from inlet probe to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. No furnace or incineration flues should be nearby.
CO	Micro	$3 \pm 1/2$	1	1	1. Must be >10 meters from intersection and should be at a midblock location. 2. Must be 2-10 meters from edge of nearest traffic lane. 3. Must have unrestricted airflow 180° around the inlet probe. 4. Must be >20 meters from dripline of trees.
CO	Middle and Neighborhood	3-15	1	1	1. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 2. Spacing from roads varies with traffic.
O_3	All	3-15	1	1	1. Must be >20 meters from dripline of trees. 2. Distance from inlet probe to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic.

Pollutant	Scale	Height Above Ground, Meters	Distance from Supporting Structure in Meters Vert.	Horiz.	Other Spacing Criteria
NO_2	All	3-15	1	1	1. Must be >20 meters from dripline of trees. 2. Distance from inlet probe to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic.
Pb	Micro	3-15		>2	1. Must be >20 meters from dripline of trees. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler. 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby. 5. Must be 5 to 15 meters from major roadway.
Pb	Middle Neighborhood, Urban and regional	2-15		>2	1. Must be >20 meters from dripline of trees. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler. 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby. 5. Spacing from roads varies with traffic.

Separation distance between roadways and stations, meters

Roadway average daily traffic vehicles per day	Micro scale	Middle scale	Neighborhood Urban Regional scale
<10,000	5-15	>15-50	>50
20,000	5-15	>15-75	>75
>40,000	5-15	>15-100	>100

References



1. "A Network Review of Montana's Ambient Air Monitoring," Air Quality Bureau, Montana Department of Health and Environmental Sciences, April, 1979.

2. "Montana 1980 Network Review," Air Quality Bureau, Montana Department of Health and Environmental Sciences, October, 1980.

3. "Montana 1981 Network Review," Air Quality Bureau, Montana Department of Health and Environmental Sciences, November, 1981.

4. "Montana 1982 Network Review," Air Quality Bureau, Montana Department of Health and Environmental Sciences, September, 1982.

5. "Montana 1983 Network Review," Air Quality Bureau, Montana Department of Health and Environmental Sciences, September, 1983.

6. "Montana 1984 Network Review," Air Quality Bureau, Montana Department of Health and Environmental Sciences, December, 1984.

7. National Ambient Air Quality Standard for Lead, Federal Register, Volume 43, Number 194, October 5, 1978.

8. "Ambient Air Quality Monitoring, Data Reporting and Surveillance Provisions," Federal Register, Volume 44, Number 92, May 10, 1979.

9. "Ambient Air Quality Monitoring, Data Reporting and Surveillance Provisions for Lead," Federal Register, Vol. 45, No. 199, October 10, 1980.

10. "Ambient Air Quality Monitoring, Data Reporting and Surveillance Provisions for Lead," Federal Register, Vol. 46, No. 171, September 3, 1981.

11. "National Ambient Air Quality Measurement Methodology; Final Rule," Federal Register, Vol. 47, No. 234, December 6, 1982.

12. "Ambient Air Quality Surveillance; Proposed Rule," Federal Register, Vol. 50, No. 46, March 8, 1985.

13. "National Ambient Air Quality Standards for Particulate Matter, Ambient Air Quality Surveillance for Particulate Matter, and Ambient Air Monitoring Reference and Equivalent Methods; Proposed Rules," Federal Register, pp. 10408-10462, March 20, 1984.

14. "Procedures for Estimating Probability of Nonattainment of PM-10 NAAQS Using Total Suspended Particulate on Inhalable Particulate Data," Office of Air Quality Planning and Standards, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, February, 1984.

15. "User's Guide for PM-10 Probability Guideline Software," Office of Air Quality Planning and Standards, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, March, 1984.

16. "Procurement of PM-10 Monitoring Equipment," Memorandum from Richard G. Rhoads, Director, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, August 29, 1984.

17. "Proposed Distribution of PM-10 Air Monitoring Equipment," Memorandum from Richard G. Rhoads, Director, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, May 7, 1984.

18. "Proposed PM-10 Standard and the Impact on Particulate Monitoring in Montana," Memorandum from Robert W. Raisch, Supervisor, Operations Section, Air Quality Bureau, Montana Department of Health and Environmental Sciences, July, 1984.

19. "The Proposed PM-10 Standard and Associated Monitoring Costs," Memorandum from Robert W. Raisch, Supervisor, Operations Section, Air Quality Bureau, Montana Department of Health and Environmental Sciences, July, 1984.

20. "Guidelines for PM-10 Monitoring and Data Reporting," Office of Air Quality Planning and Standards, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, May, 1985.

21. "Draft PM-10 SIP Development Guidelines," Office of Air Quality Planning and Standards, Research Triangle Park, N.C., 1985.

22. "Selecting Sites for Monitoring Total Suspended Particulates," U.S. Environmental Protection Agency, Publication 450/3-77-018, Revised December, 1979.

23. "Optimum Site Exposure Criteria for SO_2 Monitoring," U.S. Environmental Protection Agency, Publication 450/3-77-013, April, 1977.

24. "Selecting Sites for Carbon Monoxide Monitoring," U.S. Environmental Protection Agency, Publication 450/3-75-077, September, 1975.

25. "Guideline for Lead Monitoring in the Vicinity of Point Sources," U.S. Environmental Protection Agency, Publication 450/4-81-006, January, 1981.

26. "Microinventory Results and Use of Empirical Particulate Model at Nonattainment Sites in Montana," PEDCo ENVIRONMENTAL, INC., April, 1979.

27. "Volume III Supplementary Reports Prepared for Montana Air Quality Maintenance Area Analysis," PEDCo ENVIRONMENTAL, INC., January, 1979.

28. "Particulate and SO_2 Emission Inventory for Non-AQMA Counties in Montana," PEDCo ENVIRONMENTAL, INC., November, 1976.

29. "Billings AQMA Analysis, Suspended Particulates," PEDCo ENVIRONMENTAL, INC., March, 1977.

30. "Analysis of Total Suspended Particulate Concentrations at the Greeley School Site in Butte: 1977-1981," Environmental Studies Laboratory, Department of Botany, University of Montana, June, 1982.

31. "X-ray Studies of Airborne Particulate Matter Observed During Wintertime at Missoula, Montana," Briant L. Davis Institute of Atmospheric Sciences, South Dakota School of Mines and Technology, August, 1980.

32. "Particle Analysis by Light Microscopy, Missoula, Montana," Missoula City-County Health Department, March, 1980.

33. "Missoula, Montana, Source Apportionment Study," NEA, Inc., Beaverton, Oregon, September 3, 1980.

34. "Draft Protocol for Source Apportionment Studies in Kalispell and Bozeman," Air Quality Bureau, Montana Department of Health and Environmental Sciences, April, 1985.

35. "Deer Lodge Valley Report; Quarterly Reports 1983-1984," ARCO Minerals, Butte, Montana, July 1983 to March 1985.

36. "Protocol for Libby CMB Study," Air Quality Bureau, Montana Department of Health and Environmental Sciences, 1983.

37. "An Air Pollution Source Apportionment Study for Billings, Montana, 1978 through 1980," Master Thesis, University of Montana, Hal Robbins, September, 1981.

38. "Preliminary Results of the Libby CMB Study," unpublished, Air Quality Bureau, Montana Department of Health and Environmental Sciences, May, 1985.

39. "Survey of Residential Wood Use in Helena, Bozeman, Great Falls and Kalispell, Montana," prepared by Western Montana Scientists' Committee for the Air Quality Bureau, Montana Department of Health and Environmental Sciences, June, 1981.

40. "Statistical Package for the Social Sciences," Second Edition. Norman H. Nie, C. H. Hull, J. G. Jenkins, K. Steinbrenner, D. H. Bent, 1975.

41. "Handbook of Tables for Probability and Statistics," Second Edition, William H. Beyer, 1974.

42. Air Quality Bureau ambient and meteorological printouts.

43. Air Quality Bureau files for Montana Area and Point Source Emission Inventories.

44. Assorted maps, U. S. Geological Survey.

45. "Official Montana 1983-1984 Highway Map," Travel Promotion Bureau, Montana Department of Commerce, 1983.

46. "Montana Cities Plats and Aerial Photos," Planning and Statistics Bureau, Montana Department of Highways, 1983.

47. "Protecting Visibility; An EPA Report to Congress," Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, October, 1979.

48. "Montana Smoke Management Plan," Montana Division of Forestry, Montana Department of State Lands, and Air Quality Bureau, Montana Department of Health and Environmental Sciences, January, 1981.

49. "Billings SO_2 Dispersion Model," EPA Region VIII, September, 1981.

50. "Laurel SO_2 Dispersion Model," Air Quality Bureau, Montana Department of Health and Environmental Sciences, June, 1981.

51. "Draft Analysis of Sulfur Dioxide Episodes at the Billings Coburn Road Monitoring Site," Air Quality Bureau, Montana Department of Health and Environmental Sciences, February, 1983.

52. "Billings/Laurel SO_2 Study," Rockwell International, February, 1983.

53. "Billings SO_2 Study; Data Analysis, Model Validation and Source Determination," Air Quality Bureau, Montana Department of Health and Environmental Sciences, April, 1984.

54. "Billings SO_2 Study, Model Validation - A Response to Industries' Suggestions," Air Quality Bureau, Montana Department of Health and Environmental Sciences, May, 1985.

55. "Survey of Lead in East Helena Snow," (unpublished), Air Quality Bureau, Montana Department of Health and Environmental Sciences, July, 1979.

56. "Lead SIP Development for Montana, Technical Support Document," ETA Engineering, Inc., October, 1980.

57. "East Helena Source Apportionment Analysis Using the Chemical Mass Balance Receptor Model," NEA, Inc., September, 1982.

58. "CMB Source Apportionment Results, East Helena, Montana - 1984 Quarterly and Annual Summaries," NEA, Inc., Beaverton, Oregon, June, 1985.

59. "Air Quality Impact Analysis of the Poplar River Power Plants," Bison Engineering/Research, September, 1980.

60. "Investigation of Ambient CO Concentrations in Great Falls, Montana," Air Quality Bureau, Montana Department of Health and Environmental Sciences, February 3, 1983.

61. "Revised Great Falls CO SIP," Air Quality Bureau, Montana Department of Health and Environmental Sciences, March, 1984.

62. "Draft Transportation Control Plan to Improve Air Quality Problem Identification," PEDCo ENVIRONMENTAL, INC., May, 1982.

63. "Billings Carbon Monoxide Analysis Update," PEDCo ENVIRONMENTAL, INC., May, 1980.

150 copies of this public document were published at an estimated cost of $8.67 per copy, for a total cost of $1,300.00, which includes $1,300.00 for printing and $.00 for distribution.